OBSERVATIONS

Touching the PRINCIPLES
OF
NATURAL MOTIONS;

And especially touching

Rarefaction & Condensation:

TOGETHER WITH

A REPLY to certain *REMARKS* touching the Gravitation of *FLUIDS.*

By the Author of *DIFFICILES NUGÆ.*

LONDON,
Printed by *W. Godbid*, for *W. Shrowsbury*, at the *Bible* in *Duke-Lane*, 1677.

The Right Hon.ble Algernon Capell, Earl of Essex, Viscount Maldon, and Baron Capell of Hadham: 1701.

TO THE
READER.

READER,

About Two or Three Years ſince, I was content that Two Small Books, or rather Pamphlets, that I had collected, partly in my Youth, and partly at the Recreations of leiſure hours, ſhould be publiſhed in Print; The one Entituled, An Eſſay touching the Gravitation of Fluids; *The other,* Difficiles Nugæ, *or,* Obſervations touching the *Torricellian Experiment.*

In the Publiſhing of them, I did not ſet them off with any Oſtentation; but let them go with uninviting Titles, and not ſo much as beſtowed upon them my

Name: For I thought that they were but Trifles, and ſuch as were below the Peruſal of the Learned men of the Age, and at beſt, a Divertiſement of ſome leiſure-hours, to young Students in Matters of this Nature.

But beyond my expectation, theſe Nugæ *(for ſo I muſt ſtill call them) had the unexpected honour to be peruſed and examined by Two eſpecially of the moſt Learned Maſters in* Philoſophy *and* Mathematicks, *that this latter Age hath yielded; and not only ſo, but they have given them the honour to make Obſervations, Animadverſions and Remarks upon them.*

Thoſe which came out firſt were ſhort and obiter, *upon occaſion of another Diſcourſe, which gave opportunity of a ſhort Defence. Thoſe that came out ſince, were more large.*

The Nameleſs Author of the Eſſay *and* Nugæ, *doth return to them his thankful Acknowledgment of their Favour, in taking Notice of ſuch Trifles, and uſing them and the unknown Author with that Civility that they have expreſſed in their* Remarks.

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The truth is, the Controverſie falls to be of that Nature, that among the Three Contenders, every one oppoſeth ſomewhat that the other two grant; and aſſerts ſomewhat that the other two deny: For inſtance, *I contend againſt the ſolving of the* Phænomena *in the* Torricellian Experiment, *by the weight or Elaſticity of the Air, or by a common Spirit of Nature; but that it is done Mechanically by* Tenſion.

My firſt Opponent *ſuppoſeth it not done by* Tenſion, *nor the common Spirit of Nature, but by the Weight and Elaſticity of the Air.*

The Third contends that it is neither done by the Elaſticity or weight of the Air, nor by Tenſion; but by the Spirit of Nature.

Thus every one agrees and diſagrees with the other; and every Opponent in one kind, is in another kind the Advocate of the Party he oppoſeth.

And this will both aſſiſt and juſtifie me, in writing in the farther Explication and Application of what I have aſſerted; which I ſhall do with plainneſs and free-

ness: but without Arrogance to my self, as if I had wholly confuted my Opponents, or detraction from my Opponents, or their Assertions, by censuring them as absurd or contradictory. For in these cases, the Judgment is the Readers, not the Opponents.

In Philosophical Enquiries and Conclusions, we may observe two kinds of Methods used by some men.

Some begin at their Senses, examine particular Matters of Fact, how they are, or fall out, search into Experiments and visible Trials, and those Appearances of Nature that are obvious to our Senses, and from these they deduce their Conclusions and Theorems.

And certainly he that attentively reads Aristotle, *especially in his* History of Animals, *of their Parts, Going and Generation, in his* Meteorologicks, *in his Books* De Anima; *yea, in his very* Physicks, *will find, that as he was the greatest Master of Experience and Observation of this kind, so it was the great Method of his Deductions and Conclusions. And therefore they that when they would seem to cry up* Experimeatal Philosophy,

losophy, *think they do but right in decrying* Aristotle, *either have not considered him, or surely are too injurious to him.*

Again, There are some that lay the first Foundations of their Philosophy in Notions, and Speculations, and preconceived Systemes of their own framing; and then conforming the Solution of the Phænomena *in Nature, to those Notions. And these most commonly do by Nature and Natural Appearances, as that Tyrant did by his Prisoners that were too long or too short for his Iron Bed; stretched the latter, and cut the former to its dimension; so these handle the* Phænomena *in Nature; torture and torment them into a consonancy to their Notions; or at best, substitute new precarious Notions to piece out their* Hypotheses, *and to render sensible Appearances to hold analogy with that Notional* Systeme *of things that they have framed: And I must needs say, that I think the general Mode and Fashion of the reassumed* Philosophy *of* Lucretius, Epicurus *and* Democritus, *the Restitu-*

tion

tion and Reformation of it by Des Cartes *and* Gaſſendus, *hath too much of this latter Method in it, and is a very uncertain and prepoſterous way of forming Concluſions. I have therefore choſen the former of theſe Methods, and as near as I can, framed my Concluſions from the evidence of Senſe and particular Experiences and Experiments.*

And although it is not impoſſible for me to be miſtaken in ſome of my Experiments, and the Inferences made thereupon; yet I think I have not much miſtaken herein; only one Experiment, which I call a double Trial, pag. 84. *of the* Difficiles Nugæ, *is ſomewhat obſcurely delivered by me, and not ſo much to my purpoſe; of which I take notice in my Reply to the* 6th Remark *upon that Book.*

I have in the Beginning of this Book ſpent Ten Chapters touching the Principles of Motion, Eſſential Forms, Rarefaction *and* Condenſation; *which have a general influence into much of what is ſaid concerning thoſe matters, which often occur in the* Remarks; *and thereby I at once give my ſenſe concerning*

thoſe

thoſe difficult points, and ſave my ſelf the labour of often Repetitions or Anſwers touching things therein delivered.

The Subject of the Controverſie, I confeſs, is of no great importance, neither is the fortune of Greece (*as the Proverb is*) *concerned whether of the Controverters Suppoſitions be the trueſt; or whether, it may be, ſome other may be diſcovered truer than any of the former. All that I ſhall ſay touching our Diſcourſes of this nature, is this, That though they are not very profitable expences of time in the Writers or Readers; yet they may be innocent Diverſions to both, and may be of ſome uſe in the indagation of Natural Cauſes and Effects.*

Some Favours I muſt deſire of the Reader.

1. *That he will be contented to bear with ſuch vulgar Expreſſions which ſerve my turn to give account of my Thoughts in a Matter of this Nature; ſuch as are,* Architecture, Cones, Capes, Maſonry, *and twenty ſuch vulgar Expreſſions,*

preſſions, which, it may be, Learned men may think too mean, and repeat them with ſome diſdain.

2. *That though I do many times uſe Expreſſions that are not poliſhed according to* Grammatical *or* Scholaſtick *Niceties or Modes, that I may be excuſed herein, and that the Reader will look to the Scope and Drift; and mark at what I aim; and not cavil at bare Terms and Expreſſions, ſo long as the thing they deſign be laid open: This is an unhappineſs that too often befals men that are inquiſitive after Truth; that their Readers or Opponents miſs the ſcope of the Writer, and fall upon Criticiſmes about Words and Forms of Expreſſions. Words are but Signs of Conceptions and Thoughts; and as I have elſewhere ſaid, they perform their Office well enough, when they render our Thoughts intelligible.*

3. *That he will be content to ſuſpend his Cenſure upon Clauſes or Sentences apart, till he hath peruſed all: It is not poſſible, eſpecially in Diſcourſes*

of

of this Nature, to ſpeak or write all at once. Some things that are but ſhortly or obſcurely delivered, or perchance omitted in one Sentence, Page, or Paragraph, may be ſupplied or explained in another.

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OBSERVATIONS

Touching the Principles of Natural Motions; and especially touching RAREFACTION *and* CONDENSATION.

CHAP. I.

Concerning Motion, *and its Original.*

AS an Introduction to what follows, I ſhall briefly ſet down ſome Obſervations touching Motion of Created Material Beings; for I ſhall not in this place meddle with thoſe more Noble

Beings of Angelical or Spiritual Natures, nor the Humane Soul, which is a Subject of another and higher nature, and not to be meaſured by thoſe ordinary Rules or Reaſons that concern Bodies, Matter, and Material Natures.

We may generally find in all Material Beings the thing called Motion; in ſome of one kind, in ſome of another; ſome more ſimple, ſome more complexed and various; ſome more conſpicuous to ſenſe, as *Local Motion*; ſome leſs conſpicuous, as *Generation* and *Alteration*; ſome things are moved by others, ſome things ſeem to have the Principle or Original of motion in themſelves, which communicates motion to the Subject wherein that Principle reſides, and alſo to other things by contact of their corporeity or virtue. And therefore *Ariſtotle* ſomewhere as I remember, calls motion or endeavours of it, to be *quaſi vita quædam quæ omnibus ineſt, quæ Natura conſtant.*

The primitive Principle or Cauſe of all

all Motion is the firſt Mover, the great and glorious Lord of Nature, from whom, as being ſo, all Motion is derived into created Beings.

1. By way of cauſality; thoſe created Beings that ſeem to have the immediate Principle of Motions in themſelves, have that Principle from his *Fiat* and Inſtitution. And,

2. By way of Concurrence and Concomitance. There is a perpetual flux from that Fountain of Being that preſerves and ſuſtains thoſe Principles of Motion which he at firſt lodged in created Beings, according to their ſeveral ranks, kinds and natures, and inſtituted Durations; and if this Concourſe ſhould withdraw it ſelf but one moment, all the Motion of created Beings would ceaſe and expire.

Matter it ſelf ſimply conſidered as ſuch, though it be ſuſceptive of Motion (as we daily ſee) is not the immediate principle of Motion in thoſe ſubjects that ſeem to be ſelf-moving, or primitive Movents of other things, according to that Law of Nature inſtituted

ſtituted by the Soveraign Lord thereof.

And this ſeems apparent, among other Reaſons, by theſe that follow.

1. Becauſe Matter in it ſelf, and ſimply conſidered, ſeems to be meerly paſſive, and receptive of active impreſſions from ſomething elſe: It is true, one portion of Matter once ſet in Motion, will by contact put another portion of Matter into Motion. But we are not now upon the ſearch of intermediate Inſtrumentals of Motion, but upon the ſearch of the Principles of ſuch Motions which ſeem primitively and immediately to be elicited in any Phyſical Subject.

2. Becauſe Matter ſimply conſidered, ſeems to be one kind of uniform Entity, but diverſified by its Forms, Qualities and Modifications, as Weight, Colour, Hardneſs, Softneſs, *&c.* The Matter of a piece of Gold, and of a piece of Wood, abſtractively conſidered, ſeems to be the *Materia prima* of the Ancients, and of the ſame nature; and conſequently, if Matter ſimply conſidered were the immediate active principle

principle of Motion, the Motions of all things would be as ſimple and uniform as the Matter it ſelf. But we ſee by daily experience that there are Motions of ſeveral Subjects, which have the immediate principle of their Motion in and from themſelves, or ſomewhat within them that obtains *vicem Moventis*, and are various, differing, differently exerted, and differently terminated from the Motions of other Bodies.

Therefore if there be any things in Nature, that have their Principle of Motion in themſelves, we muſt find out if we can, ſomewhat beſides Matter, that is the immediate root or ſpring of it.

It is true, the great Maſter in Natural Philoſophy, *Ariſtotle*, tells us, that whatſoever is moved, is moved by another, which would make one ſuppoſe that he thought there were no immediate ſelf-moving principle in thoſe Beings we call *Automata*, but only the firſt Mover; and truly with reſpect to the Soveraign Cauſe of all things,

that every thing is moved by him that is unmoveable, as I have before ſhewed, cannot be queſtioned.

But that there are created Beings, that by the powerful and ſoveraign Inſtitution of Almighty God, have an immediate Principle of Motion in and from themſelves, is beyond Diſpute.

A Brute Beaſt poſſibly may be put immediately into Motion by his Appetite, and that Appetite excited by the preſence of an Object; and here the Object hath (as I may call it) a Moral Principle of Motion exciting the Appetite, moving the Brute to a nearer approach to the Object. But then in the *Greſſus Brutalis*, it is ſomewhat within him that gives the Local Motion it ſelf, namely, the *Brutalis Anima*.

And the ſame is evident in the Motions of Augmentation and Conformation of Vegetables, the motions of Aſcent and Calefaction in Fire, the Motions of Attraction and Averſation in Magnetical Bodies, and the very Motion of Deſcent in heavy Bodies;

and

and infinite more inſtances of Phyſical Bodies, which have an intrinſick principle of exciting and communicating Motion to the Subjects of their inexiſtence, and to other things: Now touching this internal immediate principle of Motion, is this Enquiry upon which I am.

CHAP. II.

A farther Diſquiſition touching the immediate Cauſe of Motion.

IN the former Chapter I have ſuppoſed theſe two things. 1. That there are ſome things that have an active ſelf-moving Principle lodged within them. 2. That Matter ſimply conſidered, is not that immediate ſelf-moving Principle: It remaines therefore to be enquired what that Principle is.

The ancient Bi-partition of created Beings was into Subſtance and Acci-

dent. But this ſeems to me to be too narrow (I am ſtill ſpeaking of created material Exiſtences) and I ſhall not be aſhamed to own *Helmont* for my Inſtructer herein, becauſe he ſpeaks with great evidence of Reaſon.

There ſeems therefore to be a third kind of Exiſtence or Entity participating in ſome reſpect of the nature of both, and yet differing in other reſpects from both; for indeed it is an Entity among created Beings belonging to Matter, far more noble than either of the two former, and is that which giveth Life, Vigor, Activity, and Motion, immediately next under the Lord of Nature, to every ſelf-moving Being.

And this Entity I call *Vis*, or *Virtus activa*, ſuperadded to Matter, and giving immediately thoſe Motions to it, that are ſpecifically appropriate to that *Vis*, or *Virtus Activa*, and without which, Matter would be ſtupid, dull, unactive, and alwayes at reſt in it ſelf, unleſs accidentally moved *ab extrinſeco*. And although thoſe *Vires* or *Virtutes*

tes activæ, the immediate Principles of Motion in ſuch things as are *Automata*, are various, and infinitely diverſified, yet I ſhall inſtance but in few; which nevertheleſs will be ſufficient to render my ſelf intelligible in what I ſay. And thoſe are principally of two ſorts; the firſt of thoſe (the nobleſt below the humane Soul) are thoſe *Vires*, or *Virtutes Eſſentiales*, that are the principal Conſtituents of vital or ſubſtantial Forms. The ſecond are thoſe which are uſually called active qualities, which ſeem to be of a lower nature and allay than the former.

Under the firſt of theſe Ranks, there are different *Claſſes*, not only gradually, but eſſentially more or leſs perfect than others, *viz.* firſt, the *Vis ſentiens & animalis* of Animals. 2. The *Vis vegetans & vitalis* of Vegetables, and poſſibly of many Minerals. 3. The *Vis combuſtiva & calefactiva* of Fire. 4. The *Vis attractiva, directiva & communicativa* of Magnetical Bodies.

Theſe *Virtutes* or *Vires Eſſentiales* even of the nobleſt ſort (I mean below the

the humane nature) have this preheminence above the Matter or Subſtance whereunto they are united, that they are the immediate, vital, movent principle, that gives a kind of Life or Motion to the Subject wherein they exiſt, which would otherwiſe be deſtitute of Life or Motion from it ſelf.

Whether theſe *Vires* or *Virtutes Eſſentiales* are in themſelves defectible or not, may be queſtioned: ſome have thought that they have certain *Termini Temporales* of their Exiſtence, and Operations in themſelves ſimply and abſtractively conſidered, and in proceſs of time languiſh and finally expire and ceaſe, as the energy of the Spring of a Watch in its evolution, grows languid, and at laſt utterly ceaſeth from any farther evolution or motion. Others have thought, and with great evidence of Reaſon, that there is no decay or natural termination of the *Vis* or *Energia Eſſentialis* it ſelf, but only by the decay or defectibility, or diſſolution of the material *Hypoſtaſis* to which it is united, or of the

the Organs which it uſeth in its operations; which being compounded Bodies, are ſubject to decay and diſſolution. And therefore the Philoſopher tells us, that if an old man had a young mans eye, he would ſee as well as in his Youth; for the decay is not in the Vifive Faculty, or *Vis* or *Virtus Eſſentialis ſentiens*; but in the Organ, or Subject, or *Subſtratum* of its Operation or Inexiſtence.

But in ſome reſpects it is inferiour to Matter, and ſeems to participate of the nature of Accidents; as for inſtance, It neceſſarily according to the common Laws of Nature, requires a material *Hypoſtaſis* or Subject in which it may inexiſt, and to which it may be united: thus the *Vis Sentiens & Animalis* is immediately united to the Animal Spirits, or the moſt refined parts of the Animal Nature. The *Vis Vegetans Vitalis* of Vegetables is immediately united to the Vital Spirits and *Succus Vitalis* of Vegetables. As to Fire, whether the *Vis Ignea* have a proper *Hypoſtaſis* of its own to which it

it is united (as the *Vis Sentiens* hath) or whether it hath no other *Subſtratum* but the Body in which it is, as the Cole or Iron, or as the common Body of the Air it ſelf, through which it is univerſally diffuſed, may, I confeſs, be queſtionable; yet certainly it hath ſome *Hypoſtaſis*, to which it is united, and primitively inexiſts, and without which, it ſeems it cannot be.

2. Whereas no portion of Matter is loſt in Nature, or annihilable but by Omnipotence, thoſe *Vires Eſſentiales* are in their individuals extinguiſhed and loſt, and no where in Nature upon the deſtruction, diſſipation or diſſolution of the neceſſary *Hypoſtaſis* or Subject of their inexiſtence: When the Animal Spirits are wholly diſſipated or diſſolved, the *Vis Sentiens* of that Animal is loſt, and no where: When water is thrown upon the Cole of Fire, the *Vis Ignea* that was in it, is extinct and *nullibi*, and (as it ſeems) doth not *faceſſere in elementum commune Ignis*, at leaſt if it have not a ſpecial *Hypoſtaſis* of its own to which it is

united;

united; and when the Magnet is burnt in the Fire, the *Vis Magnetica* in it is extinct. And the ſame is to be ſaid of that other more ignoble Principle of Motion hereafter mentioned, *viz. Active Qualities.*

And this, as I think, gives us a true notion of the Souls of Brutes, the Forms of Vegetables, of Fire, and other ſubſtantial Forms below the humane Soul.

If any ſhould ask me what I take the Soul of a brute animal to be, I ſhould ſay, it conſiſted of two eſſential parts; the one, this active *Vis*, or *Virtus Sentiens Animalis*, the Root and Fountain of all its motions, of Senſation, Perception, Phantaſie, Appetition, and Local Motion. And the other is the immediate *Hypoſtaſis* or *Subſtratum* in which this *Vis Vitalis Sentiens* primitively inexiſts, and to which it is primitively united, and by which it communicates it ſelf to the whole *Compoſitum*; and theſe are ſome ſelect *Craſis* or Portion of the Animal Spirits: For the Animal Nature

ture being a more curious piece than inferiour Subſiſtences, and fuller of variety, therefore there is a more elaborate and curious method of the union of its Eſſentials than in others: And next to Animals, there is a more curious method of union and colligation of the *Virtus Vitalis* of Vegetables to the more pure and ſubtil vital Spirits, or *Latex Vitalis* of Vegetables.

But the *Vis Ignea* and the *Vis Magnetica* ſeem to be immediately united to the whole Fiery or Magnetical Maſs: But yet ſtill the activity of both is owing not to the bare *Hypoſtaſis* or *Subſtratum* wherein it is lodged, but to that incorporeal force, virtue or energy which acts in it, upon it and by it.

And upon this accompt *Ariſtotle* is to be underſtood, when in 1. *De Anima*, he ſtiles the Souls of Brutes to be incorporeal, and yet in other places calls them ſubſtantial, *viz.* they are immaterial and incorporeal with relation to the *Vis* or *Virtus Eſſentialis activa*, which is the regnant and nobleſt part of

of them; but they are ſubſtantial, and not only ſo, but material in relation to the *prima Hypoſtaſis* or *Primum Subſtratum*, the Animal Spirits whereunto this *Vis Activa* is united, or rather ſome *Nodus* or concrement of a refined Subſtance, which is as it were the root or *Focus* of theſe Spirits, that like ſo many Branches, are derived from it, through the Nerves, and by them communicated to the whole *Compoſitum*.

And although I do here induſtriouſly omit the Examination of the Nature of the Humane or Reaſonable Soul; yet I cannot omit this ſpecial obſervation of the diſcrimination of the Humane Soul from the Souls of Brutes, *viz.* that although the appropriate faculties of the Sentient or Animal Soul be admitted indefectible in themſelves, yet their *prima Hypoſtaſis*, or immediate ſubject of their inexiſtence is corruptible, and ſubject to diſſipation; but the appropriate powers or faculties of the reaſonable Soul, namely, Intellect and Will, are not only

only indefectible powers, but alſo the *prima Hypoſtaſis* or *primum Subſtratum* of their inexiſtence is by the Divine Ordination an indefectible *Subſtratum*; namely a pure, immaterial and incorruptible Subſtance, and the union thereunto indiſſoluble; whereby it comes to paſs that the Humane Soul is immortal, and preſerved both in its Eſſence, Exiſtence, Perſonality and in duration after the diſſolution of the Body. 1. Its *Virtus* or *Vis* is indefectible. 2. The *Prima Hypoſtaſis* incorruptible. 3. The Union of both indiſſoluble by natural power.

And thus far concerning the firſt ſort of Active Principles in ſelf-moving *Automata*.

2. The ſecond ſort of motive Principles are *Active Qualities*, as they are commonly called; which, though poſſibly ſome of them may be the ſame with the former, eſſentiating Active Forms, yet ſome may be ſuch as are of a ſecond and more inferiour allay, as proceeding from the primitive forms themſelves.

I ſhall

I ſhall inſtance in two only. 1. In that of Heat. 2. In that of Gravity.

As to the former, it is evident that Heat (not only that which is ſo to the touch, but is ſuch virtually, as in Vegetables and Minerals) hath a power of exciting Motion both in the Subject of its inexiſtence, and in other Subjects, as appears in the Fermentation of Liquors and other things which are put into motion by that virtual heat that reſides in its particles, though not hot to the touch.

Whether Cold be of any poſitive nature, and ſo have a poſitive activity of its own, or whether it be an abſence only of heat, either totally, as in *ſummè frigidis*, if any ſuch be; or partially, according to the degrees of heat abated or removed, I ſhall not here diſpute; for I only propound ſome Inſtances, to render what I write intelligible.

2. As to *Gravity*, or that Principle in heavy bodies that inclines them *ab intrinſeco*, to deſcend, this ſeems to be

a quality of moſt tangible bodies that we converſe with, if not of all; for ſome contend that there is no ſuch thing in nature as ſimple Levity (at leaſt in any thing but Fire) but only ſome bodies are *minus gravia* than others, and urged to aſcend by the preſſure or circumpulſion of other bodies more heavy; this is not my buſineſs at this time to examine.

This *Gravity* I take to be a quality intrinſick to heavy bodies at leaſt, in our inferiour Syſtem of the world.

Gravitation, which is a kind of ſecond act, may not altogether improperly be applied to motions of different terminations, becauſe it ſeems to be only *niſus* or *conatus ad motum*, which may have different terminations, *viz.* upward, or downward, or laterally, and ariſe from different cauſes; but *Gravity* it ſelf, as it imports a diſpoſition, propenſion or inclination in heavy bodies to deſcend, is not unfitly ſtiled a quality, and an intrinſick quality.

For we may obſerve in the motions of

of natural bodies, ſome are from an extrinſecal cauſe or accidental; ſometimes ariſing from the preſſure of other bodies, ſometimes from the poſition of the bodies themſelves; as Water will be driven up perpendicularly by a forcer; as in Water-Engines; it will move collaterally or *per declive*, by reaſon of its own fluid nature, or by its poſition upon a declining Plain. But when all Obſtacles of that nature are removed, a heavy body, as ſuch, will move by a right Line to the Center, from that inherent quality of *gravity*, which is intrinſick to it, and puts it into motion; ſo that I am unjuſtly blamed for ſaying *Gravity* is a quality inclining bodies to deſcend to the Center, and yet at the ſame time ſaying, that it is not improper to ſay that things may gravitate upward or laterally, as well as downward; for when heavy bodies have another termination than downward, it is by reaſon of ſome other intervention of ſome external cauſe, or from ſome other property in bodies, accompanying their *Gra-*

vity, as *Fluidity* in Water or Air, which gives them a *Niſus ad motum* (which is *gravitation*) of a differing termination from that of bodies purely conſidered as heavy. But when the motion proceeds ſimply and ſolely from that active quality of *gravity*, its *niſus ad motum*, which is its *gravitation*, is ſimply *in linea recta ad centrum*, which I often call a central motion or direction: This any fair Remarker might have eaſily ſeen, without charging the Second Chapter of the *Eſſay* with a contradiction, where indeed there is none.

And therefore in this place I cannot chuſe but take notice of two extreams in the modern Philoſophy: Some are ſo wholly intent upon vital and plaſtick Principles, that they contend even almoſt againſt all Mechanical motions of Bodies, which I ſhall have occaſion hereafter to meet with.

Again, Others are ſo greatly taken up with the thoughts of Matter and Mechanical Motions, that they wholly exterminate any intrinſick Princi-

ples

ples of motion, and reſolve them wholly into Matter and its modifications, and Mechaniſm and Mechanical motions; and therefore,

1. They ſuppoſe that there are no ſuch things as I call *Active Forms* (at leaſt excepting the Humane Soul; though ſome venture hard at that alſo) but that all *Active Forms* and their Originals are only various modifications of Matter, as Size, Figure, Poſition, Texture, *&c.* This I think is impoſſible to be true; for though the Modifications of Matter may give variety of accidental or external Forms, naturally ariſing from the texture of Matter, as Figure, Colour, *&c.* And thoſe various modifications may in relation not only to the powers of the Sentient Faculty, but to other Bodies, make various impreſſions, as we ſee is done in ſome tangible effects; as by ſmoothneſs, roughneſs, hardneſs, ſoftneſs, ſharpneſs, bluntneſs, and the like: whereby ſometimes other bodies are affected; yet they can never arrive to thoſe greater activities which we ſee

in Phyſical Bodies, as Senſe, Life, Primitive Motions of ſeveral kinds, nor can be productive of the principles thereof; for the modifications of Matter can never raiſe it to ſuch an activity, as of it ſelf it is not capable of, but requires the union of ſome nobler active entity to quicken and actuate it.

2. They ſuppoſe that all the moſt noble motions, as well of Senſe as Life in Animals and Vegetables, are nothing elſe but Mechaniſm, and not from any intrinſick active principle, which we uſually call the ſentient and vegetable Soul; nay, ſome by a vain petulancy have gone ſo far as to reſolve the noble faculties and motions of the rational Soul, as Intellection, Ratiocination and Memory, into a bare Mechaniſm, and Modification, and Motion of Particles of Matter, ſuch extravagancies as theſe need no other confutation but our very Senſes, in the obſervation of the curious properties, inſtincts, operations and motions of the animal and vegetable ſouls and

and faculties, and the unevident and unintelligible explications that theſe men offer for the ſupport of their Suppoſitions; which is not my buſineſs here at large to examine.

Now touching the production of theſe active ſelf-moving Principles, which I call *Vires*, or *Virtutes activæ*.

1. As to their primitive inſtitution and production, there cannot poſſibly, as I think, be aſſigned any other than that conſtitution, inſtitution and communication which they received from the great Creator of all things, and that Law which he annexed and gave them in their firſt formation.

2. But as to the ſubſequent and phyſical production of theſe active principles, in the common and ordinary track of Nature, they are various, according to the methods ſetled by the ſame Divine Law; ſuch as are Generation, the Irradiation of the Heavens and Heavenly Bodies, eſpecially the Sun, the various mixtures of ſimple and compounded

bodies, and therewith of their essential Forms and active Qualities, whereby there arise many times such Forms and Qualities as are sometimes called equivocal, anomalous, or of various modifications. But the origination of Forms and Active Qualities, is a large Theme, and not intended to be prosecuted farther by me in this place.

CHAP.

CHAP. III.

Concerning ſome other more univerſal or common Cauſes aſſigned of Motions, viz. Anima Mundi, Spiritus Naturæ, & Principia Hylarchica.

TO ſolve or give an account of divers motions in Nature, there have been thoſe, that not content with the particular inherent active Principles in particular Subjects, as is mentioned in the former Chapters, have ſuppoſed certain more Catholick, and indeed nobler Exiſtences, that manage the various *Phænomena* in the Univerſe.

Plato and his School and after him, the *Arabian* Philoſophers, eſpecially *Avicen*, ſuppoſed an intelligent Nature ſubordinate to Almighty God, to preſide and manage the Univerſe; which

which they call *Anima Mundi*, as they aſſign one common intelligent Nature, and depute it to the excitation, action and regiment of the humane Soul in his intellective operation, which they call *Intellectus Agens*.

Others that have aſſigned ſeveral Syſtemes of the world, each having a ſpecial Province, which they ſtile *Vortices*, or *Syſtemata*, aſſign a certain common intelligent Nature to be, as it were, the common Soul of every particular *Vortex*, and thus our *Vortex*, whoſe Center they ſuppoſe to be the Sun, and the terms of extent to reach the remoteſt Limits of *Saturn*, and his Orb hath its *Anima vorticis* for the regiment of the *Phænomena* and motions within that *Vortex*.

Others again have ſubſtituted another Principle, not altogether unlike the firſt; but differing in name, and ſome qualifications. This they call *Principium Hylarchicum*, and ſometimes *Spiritus Naturæ*, which though they make not an intelligent being, yet they

they make it plaſtick, vital, incorporeal, and poſſibly ſentient; but howſoever accommodated to the regiment of Matter in the beſt and moſt orderly and convenient way; and this I take it, they ſuppoſe a ſubordinate regent principle, ſomewhat reſembling the *Archeus* of *Helmont*, which is ſuppoſed a middle principle, intervening between the Souls of Animals and their Body, and an immediate active inſtrument in its motions and operations.

If by this *Principium Hylarchicum*, theſe men would underſtand the Soveraign Creator and Lord of the world (as many of the Ancients underſtood the *Anima mundi*) who is intimately preſent with all his Works, and by a continual influx ſupports them in their being and motions, according to the moſt wiſe Laws and Inſtitutions that he hath eſtabliſhed for them and fixed in them: Or if by the *Spiritus Naturæ* they underſtand thoſe active eſſential Virtues communicated to every created Being by the Glorious God,

God, and that ſtatuminated Law, and Order, and Method, and Oeconomy which he hath given them, and according to which thoſe active principles which he hath planted in them, do exert and operate; this will be readily agreed to them as moſt rational, and in a great meaſure evident, not only to our Reaſon, but to our very Senſe and Experience, and the Diſpute about words, would ceaſe, and be at reſt.

But the ſubſtitution of ſuch a vicarious, immaterial, common Principle, to regulate, order, excite and govern Matter, and its motions ſubordinate to Almighty God, a common Spirit, and different from the particular active principles variouſly implanted in Phyſical Bodies, though it be a pleaſant ſuppoſition, yet it is difficult, if not impoſſible to evince to any tolerable ſatisfaction. Only I muſt needs ſay, that as Suppoſitions of this nature, that are founded upon Notions, are for the moſt part unacceſſible by thoſe common *Media* whereby things are

to

to be proved to humane underſtanding; ſo upon the ſame account they are difficult to be confuted: If any man ſhould tell me that the Moon were a Globe of Water, as he could never prove it, ſo I could never diſprove it, unleſs I had ſuch *Media* of acceſs to that Body, that could to my Senſe and Experience confute it; and therefore in ſuch caſes the proof muſt be caſt upon the aſſertor

Yet there ſeem to be ſome things that render this Suppoſition not very credible.

1. That it ſeems an unneceſſary multiplication of beings, whoſe Offices are well enough ſupplied without them; namely, by the energy of the glorious God, and thoſe ſpecial active Principles that he hath lodged in almoſt all created Natures, and thoſe Inſtitutions and Laws that he hath alligated and annexed to the particular Works of his Creation, and the Syſtemes and Syntaxes of the World.

2. But principally upon a ſtrict examination,

amination, it will appear that moſt of theſe *Phænomena* in nature and motion, are performed by the active principles, reſiding in particular Subjects, or by the uſual and neceſſary Mechaniſm of bodies, without our calling to their immediate performance this ſuppoſed Spirit of nature.

3. Again, It is very difficult to form to our ſelves a notion of this Spirits Nature, that may have any probable certainty: let us take but theſe few difficulties.

1. Is it a diſtinct, ſelf-ſubſiſting Spirit, ſeparated from Matter? or is it a kind of common Soul or Form reſiding in the Univerſe, as the Soul of a Brute reſides in his Body, and united to it by a wonderful union? If it be the former, it is a kind of Angelick Nature, not united to Matter, but acting ſeparately upon it, ſubſiſting without it, and is in all probability an Intelligence. If the latter, it were fit to know whether it were an immaterial Form, as the Humane Soul; and then perchance

we

we ſhould give it too great a preference: Or is it a material Form, as that of Brutes? And then it will be worth knowing whether it hath the like perfection of Senſe, or be of a lower allay, and only vital, like thoſe of Vegetables. Or is it a kind of connatural Senſe, ſuted to all material Beings, together with a ſentient perception and appetite, proportionate to the Nature of every material or ſubſtantial created being, as *Campanella* and our learned Countriman hath lately aſſerted. Whatever it be, we are perfectly in the dark to form any conception of it with any tolerable evidence or ſatisfaction.

Again 2. Are there other particular or ſpecifical Forms in the ſeverall *Claſſes* of material Exiſtences, as Animals, Vegetables, Minerals, *&c.* that exert the ſeveral operations that ſeem ſpecifical to their Natures, but individuated in the ſeveral individual exiſtences, Or is this common ſpirit of Nature that which exerts all theſe Operations which are

therefore

therefore only diverſified by the diverſification of the compoſitions of thoſe bodies in which and through which they are exerted, as the common Bellows in the Organ; and the breath thereof gives the various ſounds in the Organ-Pipe, according to their Figures, Stops or Amplitudes? If we ſuppoſe the former, we ſeem to multiply Entities without neceſſity; if the latter, we deſtroy all that we are building, and make all the Animals, and Vegetables, and Material Beings in the Univerſe (if this Spirit be univerſal) or in this lower World (if ſingly belonging to this Syſteme) to be nothing elſe but pure mechanical pieces, without any ſentient or vital principle of their own, but only are the dead Tools and Inſtruments of this ſpirit of Nature; ſuch difficulties as theſe would be cleared, to give us ſome *Idea* or probable fixed notion of this Spirit of Nature, or *Hylarchical Principle*.

But now if we ſhould ſuppoſe the interpoſition of this common Spirit of

of Nature in ſome *Phænomena* or motions of particular Bodies, yet it ſeems neceſſary for us to ſuppoſe theſe two things in the exertions thereof.

1. That it doth not immediately interpoſe, unleſs upon great emergencies, and to deliver the things of Nature from ſome important inconvenience, which without ſo effectual an interpoſition would befall them; as to preſerve the continuity of the parts of the Univerſe, or avoid vacuity, and the like, and not upon thoſe little occaſions which are of no conſideration and importance, whether they be relieved or ſupplied or not; ſuch as are the emergency of a Rundle of light Wood from the bottom of the Water, or the ſuſtaining of a weight, or attraction by the *Embolus* of a Syringe or Air-Pump, or the keeping up of the *Valve* or *Operculum* in the lower end of a Tube immerſed in Water. Theſe and the like Inſtances are of ſo ſmall concernment to the good of the Univerſe, or to the Nature of Phyſical Bodies, that they were ſcarce worthy

the acceſs of the noble Spirit of Nature; *Nodi vix tali vindice digni.*

2. That if this Spirit of Nature doth at any time interpoſe, yet it rarely, if at all, acts by violent or convulſive motions, but pacately, and as much as may be, in conſonance to the regular diſpoſition of Bodies; and therefore it is, that even in Animals, where their motion is exerted by a clear, internal, vital, ſentient principle, it doth for the moſt part act regularly, and in the beſt Mechaniſm imaginable, their Bodies, Nerves, Bones, Muſcles are ordered by a rare and excellent Mechaniſm for the exerting of thoſe motions, and the motions themſelves performed by thoſe Organs, by the exploſion and retraction of the Spirits in their ſeveral veſſels, with admirable order and artifice, as will appear to any that will beſtow the pains to read *Galen*, *De uſu Partium*, and *Ariſtotle*, *De Greſſu Animalium*; and therefore we have much more reaſon to think that this ſuppoſed noble Spirit, the Spirit of Nature, acts not at

at random, or convulſively, or irregularly, but according to the beſt Rules and mechanical methods applicable to ſuch motions as it doth occaſionally exert.

So that if we ſhould never ſo much allow of the Spirit of Nature, and its interpoſitions, yet ſtill the neceſſary inſtruments, modes and methods of its motion according to Mechanical Rules, muſt ſtill be ſought after.

For it would be a pitiful refuge for a man pretending to Philoſophy, to give this general ſolution to all *Phænomena* of Nature, that this is ſo, becauſe the Spirit of Nature thus orders it; without giving ſome probable account of the particular means or method by which the Spirit of Nature effects it, and likewiſe of the end, uſe and deſign of the Spirit of Nature in what it thus effects.

Chap. IV.

Touching Rarefaction *and* Condenſation, *and their kinds.*

BEcauſe much hath been ſaid by others touching *Rarity* and *Denſity* of Phyſical Bodies, which I call Affections, Paſſions or Qualities of Phyſical Bodies; and it may be conducible to the ſolution of many Phyſical *Phænomena*; and to the clearing of my apprehenſions concerning it, and to the anſwering of moſt of the Objections of any weight, made againſt the Suppoſitions which I have ſtated, in the two Pamphlets above mentioned, I will endeavour to give that account concerning this matter, that ſeems reaſonable to me; though I muſt confeſs it is poſſibly one of the abſtruſeſt Subjects in Natural Philoſophy, wherein I ſhall obſerve as near as I can, this Method.

1. To

1. To conſider the ſeveral conſiſtence of Bodies.

2. To ſhew the various kinds of Rarefaction and Condenſation of thoſe Bodies.

3. To what kinds of Bodies, and to what kinds of *Rarefaction* and *Condenſation* this Argument in hand is applicable; that ſo we may come cloſer to the buſineſs in queſtion, and ſpeak *ad idem.*

As to the firſt and ſecond, Sir *Francis Bacon* in his *Hiſtoria Denſi & Rari*, hath in a great meaſure fitted them to my hand; whoſe Method I ſhall herein follow.

1. Of Bodies, ſome ſeem to be properly called Tangible, ſome *Pneumatica*; which though they are not Spirits, nor void of Matter, no, nor yet totally imperceptible to the Touch, yet are more ſubtil, and leſs obvious by any groſs contact, to that Senſe, and therefore may be called *Spiritalia.*

Of the former ſort, ſome are more fixt, and of a more ſetled conſiſtence,

as *Gold*, *Iron*, *Stone*, *Wood*, &c. Others are fluid, either from the texture of their Nature; as *Water*, *Oyl*, *Mercury*; or by Art or Accident, as *Gold*, *Silver*, *Lead*, &c. in Fuſion or Diſſolution.

Of the latter ſort, *viz. Pneumatica*, there are ſeveral kinds, and of various degrees of exaltation, as *Æther*, *Air*, *Flame*, *Spirits of Animals* or *Vegetables*, *Smoke*, *Vapors*, &c.

Although tangible Bodies may be capable of *Rarefaction* and *Condenſation*, at leaſt in ſome of the acceptations thereof hereafter deſcribed, yet I ſhall not much meddle with them, unleſs it be ſuch as be fluid, becauſe not to my preſent purpoſe; and becauſe what is hereafter ſaid touching the *Rarefaction* or *Condenſation* of ſome Fluids, and of thoſe *Pneumatica*, will in ſome meaſure explicate ſomewhat concerning the *Condenſation* or *Rarefaction* of other tangible Bodies.

2. Touching *Rarefaction* and *Condenſation*, thus much firſt in general

is

is to be ſaid, *Rarefaction* is when the ſame Body, or at leaſt portion of material Subſtance, takes up a greater external dimenſion, or a larger ~~appearing~~ trine dimenſion, *viz.* of breadth, length and depth than it had before.

And on the contrary, *Condenſation* is when the ſame Body or portion of material Subſtance takes up a leſs external dimenſion than it had before; this may ſuffice as the common *Phænomenon* of *Rarefaction* and *Condenſation*, as it ſtands objected to our ſenſe; though when we come to particulars, this general ſenſible deſcription of either will not ſerve alwayes the Subject, nor ſufficiently explicate it.

Some Appearances in Bodies look like *Rarefaction*, which indeed are not ſuch, but only in appearance; ſuch as are *Augmentation of Bodies* by an unperceptible acceſſion of new matter, as in *Augmentation*; ſometimes by aſſimilation of contiguous matter into its own conſiſtence, ſometimes by the apertures or diſtraction of the

parts of a Body, and intruſion or intermiſſion, or attraction of other Matter of a different Nature, Quality, or Texture, or of the ſame Nature, Quality or Texture with it ſelf; theſe are not truly thoſe kinds of *Rarefactions* whereof our enquiry is inſtituted; for though the *Moles* or Bulk ſeem to be extended and enlarged, yet the true Bulk of the ſame Matter is the ſame as before, though it may be under a different configuration or poſition.

Again, on the contrary, ſome appearances in Bodies, look like *Condenſation*; but in truth are not ſuch; as when part of a Body is emitted either by perſpiration or diſſolution of ſome of its more ſubtil parts, whereby that which remaineth, taketh up leſs circuit or bulk, or where ſome of its parts are firſt ſubtilized, and then diſmiſſed, and ſome other Inſtances of like kind may be given; but theſe are not true and real *Condenſations*; for the entire matter remaines not in the Body condenſed, as was before, but is dimi-

diminiſhed: Theſe therefore are not the *Rarefactions* and *Condenſations* whereof the Enquiry proceeds; for the ſame Body in both inſtances hold the ſame true ſpace it had before, though the extream appearing Limits ſeem to be altered.

3. The Queſtion therefore in hand is, touching that kind of *Rarefaction*, where the ſame Body or portion of material Subſtance, without acceſſion of more or other bodily matter, yet takes up a larger ſpace than it did before.

2. And where it doth not only take up a larger exterior compaſs, circuit or ſuperficies; but where it alſo fills thoſe intrinſick ſpaces which are within the circuit of that extent, as fully as it did before. For if for the purpoſe, a portion of Air of a Cubique Figure ſix inches ſquare, do ſwell to a Cubique Dimenſion of ſeven inches ſquare, yet if in that very dilatation there be as great a disjunction or divulſion of the parts of the Air within the cubique ſpace of ſix inches, as amounts

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to that external acceſſion of one inch, whereby it becomes a Cube of ſeven inches ſquare, here is no true *Rarefaction*, nor is the ſpace enlarged, but only the Figure of the ſame Body, and of its Extention altered.

If an Artificer take a little Cylinder of Silver of two inches long, and half an inch round, and guild it, he will by his Art draw out this little Bar into 40 yards or more of fine Silver Thred, though the length be encreaſed, yet the breadth is diminiſhed, and the Silver Thred takes up no more true extent of its trine dimenſion than it had before; nay, which is remarkable, the extent of the *Superficies* of the Silver is not enlarged, though the figure be altered; which appears by this, that every part of the *Superficies* of the Silver thred will continue guilt as it was in the *Superficies* of the *Ingot*.

And upon the ſame account it is on the other ſide, when a Body or portion of material Subſtance is ſaid truly to be *condenſed*.

1. It

1. It muſt be the ſame portion of matter that was before. without any diminution of its parts, or of any matter in it that contributed to its former *Moles.*

2. The ſame matter without any diminution, muſt really take up leſs room or ſpace than it did before; for if it only take up a leſs *Superficies* or external extent, yet withal it makes up ſpaces or poroſities within the compaſs of that external extent, which before was not filled by it ſelf, but either was ſimply empty of any body, or only filled with ſuch a body as now recedes, and gives way to the body ſuppoſed to be condenſed, to take it up, then here is only a change of the ſpace it had before, and of its configuration. not a leſs ſpace really taken up as commenſurate to that body that is ſuppoſed to be condenſed. So that the Queſtion between the ancient and modern Philoſophy, is not ſo much *de modo*, how *Condenſation* or *Rarefaction* is made, as concerning the thing it ſelf, whether really

ally and truly there be any ſuch thing or affection in bodies as *Rarefaction* and *Condenſation*; the latter Philoſophy in truth denying the thing, when they give it ſuch an explication as really and in truth conſiſts not with it; as we ſhall ſee hereafter.

This being therefore the ſtate of the Notion of *Rarefaction* and *Condenſation*, in its true explication, we are to conſider, what bodies, or motions in bodies are ſuch as are applicable to the Argument in hand.

The ſpecial Inſtances that I ſhall uſe are theſe.

1. The *Rarefaction* or *Condenſation* of bodies by Tranſmutation; thus Water by *Rarefaction* is ſometimes changed into Air, which hath thereby a greater extenſion than it had before by about 900 times; and Air by *Condenſation* is changed into Water, and thereby loſeth by contraction a like proportion of ſpace than it had before. Thus *Ariſtotle in* 4. *Phyſ. cap.* 9. and the great *Verulam, in Hiſtoria Denſi & Rari, pag.* 88.

2. The

2. The *Rarefaction* that is cauſed by external violence, as in the *Air-Pump,* in the *Cacabus Evacuatorius*, and the *Magdeburg* Engin, this is a *Rarefaction* by Tenſion, whereby the Air is dilated, not only in its external Bulk, but in all the parts of it, and in its internal, as well as external parts and dimenſions. And thus *Merſennus* and others tell us, Air may be dilated to near 70 times its former and natural extent.

3. The *Condenſation* that is made by Compreſſion: Some there are that think Water is thus contractible and condenſible by compreſſion: The ſame *Verulam*, *ubi ſupra*, pag. 99. tells us, that taking a Leaden hollow Globe, and fill it with Water, and then ſtrongly ſtop the Orifice which took in the Water, and compreſs the Globe in a ſtrong Preſſer, whereby it may be reduced to an eighth part of its former dimenſion, the Water will ſuſtain that contraction; but if it be preſſed farther, the Water will diſcharge it ſelf through the Globe *ad modum*

modum parvi imbris. It is not impoſſible but it might do ſo from its firſt compreſſion, though the ſtreams, by reaſon of their exility, were imperceptible to the Eye, as the emanation of *effluvia* through the pores of the bodies of Animals, electrical effluxes, or the Odors of Herbs; for Water, though fluid, ſeems very impatient of *Condenſation* by compreſſion; yet it is not impoſſible, if under a very ſtrong preſſure; but to the very eye it appears capable of dilatation by Tenſion in its diſcharge of it ſelf by Bubbles, upon a ſtrong Tenſion.

But howſoever it is with Water, it is apparent that Air is capable of condenſation and contraction by compreſſion; this appears viſibly in the compreſſion of the Air by Wind-Guns, and the careful injection of water by a well ordered Syringe in an empty *Æolipile*, ſo that Air by theſe means may be contracted into a ſeventh, nay poſſibly a ſeventieth part of its natural ſpace or dimenſion.

4. The

4. The *Rarefaction* and conſequential dilatation of Bodies by Heat or Fire: Thus Water it ſelf is rarefied and extended into Vapours by Heat. The Lord *Verulam*, *ubi ſupra*, pag. 28. gives us a notable Inſtance, by taking a Vial-Glaſs holding an ounce, filling it half full of Spirit of Wine, then taking an empty Bladder that held about 8 pints, and tying it about the neck of the Vial ſtrictly, the Spirit of Wine heated upon the Coals, the *Aura Spiritus Vini* filled the Bladder, and yet only ſix penny weight of the *Spirit of Wine* ſpent, which did not amount to the 40th. part of a pint, yet filled the Bladder of 8 pints with its rarified Air. And although this Inſtance be in the *Spirit of Wine*, which is fuller of ſubtil Matter than the like quantity of Water, yet it will hold its proportion with the Fumes or Vapours of Water.

And of the like kind is the *Rarefaction* by Ignition in the Gunpowder, where a grain of Gunpowder fired, will expand above a thouſand times

times its former dimenſion and more.

But that which is moſt obvious to Senſe, and moſt appoſite to my purpoſe, and therefore will be the Subject of moſt of my enſuing applications, is, the *Rarefaction* of *Air* by heat, whereby it may gain an expanſion of above 70 times its natural ſize and dimenſion, as is eaſily found by the ſtrong heating of a ſtrong Braſs concave Globe, which if the included Air have no vent, will break it, and if it have a vent, and after it is ſtrongly heated, caſt into a Veſſel of Water, it will ſoon diſcover the proportion of its dilatation by the contraction that it receives from the cold Water, and by the quantity of Water it ſucks in upon that contraction.

5. The *Condenſation* and conſequential contraction that the Air receives by the conſtipation of it by Cold, eſpecially after a ſtrong dilatation; but although there be no ſuch preceding dilatation or expanſion of the Air by heat, yet it is viſible in

in Weather-Glaſſes, and other Engines of that nature, that the Air is contracted in its dimenſion, by the ambient Cold, from what it uſually hath at other times.

CHAP. V.

Concerning the Phænomena *of* Rarefaction *and* Condenſation *apparent to Senſe.*

TO purſue all the *Phænomena* of *Condenſation* and *Rarefaction* in its full Latitude, were too long a buſineſs, and not ſo much conducible to my purpoſe: I ſhall therefore take up thoſe *Phænomena* that are apparently evident to Senſe in the *Rarefaction* and *Condenſation* of Air; for the due diſcuſſion of that ſingle Subject will give an eſtimate and explication of other *Rarefactions* and *Condenſations.*

1. It is evident to our very Senſes, that a ſmaller portion of Air, ſuppoſe

a Cubique Foot in a Veſſel, being rarified by heat, will take up a far greater ſpace than it did before ſuch application, and the like will be when it is done by Tenſion, as in the *Air-Pump*, and the *Magdeburg-Engin*; for when a great part of the Air is driven out by Heat, in the one Inſtance, and drawn out by Traction, in the other; yet it is evident to Senſe, that the Receiver or other Veſſel remains full of a very rare and extended Air; for ſenſibly no other Subſtance ſupplies it.

2. It is evident to Senſe, that this diſtenſion of the Air is not only in the *Extima Superficies*, but in all the very internal parts of it; for it is apparent to our Senſe, that it hath a viſible effect as well upon the Birds, Water, or other Body, placed in the middle of the Cavity of the Receiver, as in thoſe that are conterminous to the Sides of it, as appears in thoſe many Inſtances given by Mr. *B.* eſpecially in 21, 22, *&c.* Experiments. And unleſs the whole Body were extended

tended every where and every way, it were impoſſible that a little portion of Air included in a Bladder, ſhould encreaſe its bulk by Heat, to ten times its extenſion, as it will do, and is apparent to our Sight by the ample diſtention of the Bladder.

3. It is apparent to our Senſe, that if the Air be ratified by Heat in any cloſe Veſſel, as the Heat, which is the cauſe of its *Rarefaction*, decays, ſo the Air endeavours its contraction, to gain its primitive ſize, which it then attains, when the Heat is perfectly gone out, if it be not impeded by the cloſeneſs of the Veſſel.

This is viſible in *weather-Glaſſes* of 22 inches long; whereby, when for the purpoſe, the Water riſeth to ten Inches, and leaves twelve inches of Air in the Head of the Glaſs, the warm hand laid upon the Head of the Glaſs, will depreſs the Water, by expanding the included Air two or three inches, but the Hand being removed, the Air will contract it ſelf to its former Staple, and ſo the

Water will riſe to ten, as before.

4. It is evident to Senſe, that the Air contracting it ſelf, doth by that which is called by ſome, *Motus nexus*, lay hold of the inward ſides of a cloſe Veſſel containing and ſtrictly impriſoning it; and if they be otherwiſe ſeverable, yet the ſtrong contraction of the filaments of the Air holds them together, as appears abundantly by the Inſtance of the *Magdeburg Hemiſpheres*, mentioned at large in the 18th. Chapter of the *Obſervations* upon the *Toricellian Experiment*, and other Inſtances of the like Nature, given in that Book.

5. It is evident to Senſe, that in that ſtrong coheſion of the Filaments of the Air to the ſides of the Veſſel, when by the decay of Heat, it contracts it ſelf with a *motus* or *conatus* of reſtitution, and with it the ambient Veſſel by a *motus nexus*, yet if a ſmall degree of Heat be moved to the Veſſel, that contraction is relaxed, and the Veſſels fall aſunder; and the like is done by the ſmalleſt admiſſion of the

the free or ſolute Air, though through a Pin-hole; for by the Heat the included Air is again dilated, left lax, as before it grew cold, and by the admiſſion of foreign Air, the included Air is relieved gradually to that expanſion as is natural to it, and as it had before its *Rarefaction* or *Condenſation.*

6. It is evident to Senſe, that upon the ſmalleſt Pin-hole made in the Veſſel where the Air is, that thus contracts and endeavours its reſtitution, either upon Tenſion, or upon growing cold after *Rarefaction*, the Air thus tenſed or contracting it ſelf, will greedily ſuck in the foreign Air, yea, or Water, for its relief againſt that Tenſion that it is under.

7. In *Condenſation* of Air, eſpecially by compreſſion, it is apparent, that the Air takes up, or may take up a far leſs room than is natural to it, as appears in Wind-guns or *Æolipiles.*

8. It is alſo apparent to Senſe, that the compreſſed Air in thoſe Inſtances,

endeavours with great ſtrength and force its relaxation from this compreſſion, in ſo much as if it can get liberty, it will caſt out a Bullet with great force in Wind-guns, and in *Æolipiles* well made, and well charged with Water, by a Syringe it will throw up the Water above twenty foot high.

Theſe *Phænomena* are as evident to our Senſe of Sight and Touch, as any thing we ſee or feel; and though there is difference among the Learned in the ſolution or manner of explication of theſe *Phænomena*, yet the effects themſelves are plain and ſenſible, and do give a ſenſible demonſtration that ſurely there is ſome alteration of the ſtate of this Body of the Air, or of its Texture or Fabrick under theſe various Appearances, which are uſually called *Rarefaction* and *Condenſation*. But whether they are really ſuch, or how made or ordered, will be the Subject of farther Enquiry.

CHAP.

CHAP. VI.

Concerning the various Solutions of Condenſation *and* Rarefaction, *and firſt, of that which is by ſuppoſed interſperſed Vacuities.*

Rarity and *Denſity* of Bodies, although it terminate in a greater or leſſer dimenſion or extent, which properly reſpects Quantity, yet they ſeem in themſelves to be but various Paſſions, Affections or Qualities of Bodies ariſing from their different Textures, either more craſs or more ſubtil: And *Rarefaction* or *Condenſation* of Bodies ſeems to be thoſe ſeveral Motions towards theſe Qualities of *Rarity* or *Denſity*, cauſed for the moſt part by ſome external or adventitious Agent, which changeth and altereth the Texture of any Body whereby it aſſumes thoſe Qualities of *Rarity* or

Denſity different from its own natural conſtitution, and ſutable to the variety of the Texture they do for the time undergo.

There have been various Solutions or Explications of theſe apparent *Phænomena* of *Condenſation* and *Rarefaction*, which I ſhall in the next place conſider; holding my ſelf to that of the Air, either by compreſſion, in caſe of *Condenſation*, or by expanſion by Heat, or by Tenſion by force, in caſe of *Rarefaction*; becauſe this Inſtance of *Rarefaction* and *Condenſation* of the Air, is moſt obvious to Senſe, and doth in a great meaſure explain the *Rarefaction* or *Condenſation* or other Bodies capable of thoſe Affections.

Theſe Methods of Solutions of Explications of *Rarefaction* or *Condenſation* that have been taken up by ſeveral parties, are principally three.

1. Of thoſe that ſuppoſe the ſame to be performed by reaſon of interſperſed Vacuities, Poroſities, or Spaces, empty of all body interpoſed between very particles, which in caſes of *Rarefaction*,

faction, are made wider by a kind of divulſion or greater apertures of the particles of Air, or other bodies rarified, whereby the *Interſtitia* of the aerie Particles are greater, and thoſe empty interſperſed Vacuities made larger; and in caſe of *Condenſation*, the aerie Particles are crouded cloſer together, and thoſe empty ſpaces or *Interſtitia* made leſs by reception of thoſe particles of Air into thoſe Vacuities, in a cloſer poſture or conjunction than they were before ſuch compreſſion, conſtipation or condenſation; and this I call the *Epicurean* Solution.

2. Of thoſe that admit no Vacuities at all in the Univerſe, but that all places or ſpaces are full of ſome body or other, but that in the *Rarefaction* of the Air, whether by Heat (which I call ſimple Rarefection or Expanſion) or by a forcible diſtraction or divulſion of the particles of ſuch rarefied or expanded body by force, which I call Tenſion, thoſe particles of the extended or rarefied body, are removed to a greater diſtance one from another,

another, and as they are ſo removed, other more ſubtil, corporeal particles do interpoſe gradually, and fill up thoſe *Interſtitia*; and in caſe of *Condenſation*, the more ſubtil parts with which all bodies are furniſhed, but eſpecially the Air, are driven out by compreſſion, and take up a temporary reſidence at leaſt in the conterminous Air. And this I call the *Carteſian Solution*, though this, as ſhall be ſhewn, have ſome variation in the manner of its explication.

But though theſe methods differ in the application to the matter in hand, yet they both much agree in this, that the firſt material Principles of Bodies are certain minute Corpuſcles or Atoms; which, though they are really bodies, and therefore Mathematically diviſible, yet they are ſo minute, that phyſically and actually they are indiviſible; and therefore in themſelves hard and unfrangible into leſſer portions. This I ſhall examine hereafter in the ſeventh and eighth Chapters.

3. The

3. The third Solution is that of the ancient Philoſophers, and ſome other of the Modern, which ſuppoſe that *Rarity* and *Denſity* are really natural Affections or Qualities of Phyſical bodies, and that *Rarefaction* is a real expanſion of the very entire *Moles* of the body truly rarefied; and *Condenſation* is a real contraction of the whole dimenſion of the body condenſed, namely, where it is truly and formally a true *Rarefaction* or *Condenſation*, as the Queſtion is above ſtated in the beginning of the Fourth Chapter: And this I call the *Ariſtotelian Solution*; and ſeems to me the trueſt, in the manner hereafter de-deſcribed.

Firſt therefore, Touching the firſt of theſe *Solutions*, by interſperſed Vacuities: This, though it doth in truth take away the true Notion of *Rarefaction* and *Condenſation*, as it is before ſtated; for ſtill the ſame body holds but the ſame quantity of ſpace, though in different poſition or ubication of its parts, yet I muſt needs ſay,

were

were the ſuppoſition of interſperſed Vacuities true, would in a great meaſure (though not altogether) ſalve many of the *Phænomena* of *Rarefaction* and *Condenſation*.

But there are theſe two grand Objections, that I think render this *Solution* impoſſible to be true.

1. It ſeems to me utterly untrue, that there are any ſuch interſperſed Vacuities, wholly deſtitute of Body, either in the Air or any other Body, and herein the *Carteſians* and I agree. And that which renders this Suppoſition untrue, is that excellent demonſtration improved by Sir *K. Digby*, in his *Hiſtory of Bodies*.

If there were ſuch interſperſed Vacuities, it muſt neceſſarily follow that thoſe Bodies of an equal *Superficies*, that are more rare, muſt have more or greater interſperſions of ſuch Vacuities, than ſuch as are more denſe; or which is all one, the ſame *Moles* of body that is more denſe, muſt needs have more of matter or body in it than that which is more rare; or which

ſeems

ſeems to be equally conſequential, that where the body is more weighty, the ſame external *Moles* of the more weighty body muſt needs have more of body, and leſs of interſperſed Vacuities than that which is more light, where the external *Moles* of either is equal.

And therefore a Cubique Foot of Gold muſt have more of Body, and leſs of interſperſed Vacuities than the like Cubique Foot of Silver, and that than the like Cubique Foot of Water; and that than the like Cubique Foot of Air.

The Lord *Verulam*, in his *Hiſtoria Denſi & Rari*, pag. 8 & 9, by an exact computation, gives us the Eſtimate of the diſproportion of Weight of the ſame extrinſick *Moles* of ſeveral bodies; whereby he finds that a portion of pure Gold reduced into a Cubical Figure or *Moles*, weighed 20^{d} weight, and the like *Moles* of of *Mercury* 19^{d} weight and 9 grains; the like *Moles* of Silver weighed 10^{d} weight and 21 grains; and the like

Moles

Moles of Water weighed 1d weight and 3 grains; and upon a like trial, *pag.* 20. found, that the heavier any ſolid body is, and more united its parts are, the lighter was the ſame body reduced into Duſt (though cloſely compreſſed together) in compariſon to the weight of the ſame body before its pulverization.

His Experiment goes not ſo far as the diſproportion between the weight or denſeneſs of Air or Water, but *Merſennus* and ſome others that have been curious in this Computation, tell us, that the ſame extrinſick *Moles* of Water is about 14 times lighter than the like *Moles* of *Mercury*; and the ſame *Moles* of Air is at leaſt 900 times, others ſay, 1300 times lighter than the like *Moles* of Water.

The conſequence whereof is, that if we ſhould ſuppoſe a Cubick inch or foot of *Mercury* to be entirely full without interſperſed Vacuities or other Matter in it (which yet upon the account given, wants much) it muſt follow that in one Cubique inch or foot,

foot, or other *Moles* of Air, for one particle of body, there muſt be 11699 parts of empty ſpace, each of theſe ſpaces equal to the ſpace that the real body of the Air takes up; ſuch is the diſproportion of the weight between the like quantity or *Moles* of Air to that of like *Moles* of *Mercury*, *viz.* as 1 to 11700.

The conſequence whereof would be, that yet the Cubique foot, or inch, or other meaſure of a Veſſel containing nothing but Air, might receive a quantity of *Mercury* that bears proportion, as 11699 to 1, and a quantity of Water as bears the proportion of 899 to 1, without extruding any part of the included Air, or overfilling or breaking the Veſſel wherein it is included. And if we ſhould ſuppoſe that in the common Air we breath in, there ſhould be but 891 parts of Vacuities, for one part of true ſubſtantial Air (as there muſt be upon this ſuppoſition) all reſpiration would preſently be obſtructed, and indeed all that Motion which we ſee, eſpecially in Meteors.

But

But as this is prodigiouſly incredible, ſo it is apparently untrue: For take a Tube full of Air, and ſtop it at one end, immerſe the open end into Water, and preſs it down as low as may be, yet not one half of the Tube will be filled with Water; nay take an *Æolipile* of Braſs with a Syringe to drive in the Water, it will with great difficulty receive into it $\frac{1}{4}$ parts of Water; and thereby the Air contracted into a quarter of its former room, and with great pains and force it may be, into a much leſs room; but never any pretended it could be compreſſed into the 899th part of its former room; and yet thus it may be, and with great eaſe, becauſe here are 899 empty ſpaces which may receive the water with as much eaſe as if the Bottle or veſſel were not empty only of Water or Air, but perfectly empty of any other body, abating only $\frac{1}{900}$ of the room to receive the Air.

if the ſuppoſition be true,

2. The Second difficulty in this Suppoſition ſeems to be this, that it doth

doth not anſwer the *Phænomena*, eſpecially in condenſation of Air by preſſure, as in *Wind-Guns* and *Æolipiles*, which viſibly with a great force endeavours its reſtitution, as appears in the exploſion of the Air in *Wind-guns*, and ejection of Water preſſed into *Æolipiles*; for the Air upon this Suppoſition, hath a free room far more than ſufficient for its reception, and therefore hath no need of any ſuch violence in its motion of reſtitution, it having 899 empty cavities, where as it hath need but of $\frac{1}{900}$ part thereof for its reception, and mere vacuity can contribute nothing either to reſiſt compreſſion, or to cauſe a ſenſible force of reſtitution, becauſe nothing can have no activity or motion.

3. Again, if Air or Water be ſtrongly rarefied by Heat, we ſee it takes up a larger extention than before it had, and that with ſuch an energy and force, that it will break a ſtrong Veſſel incloſing it; which it could never do, were there any conſiderable interſperſions of Vacui-

ties; because the body of the Air would with much more ease break into those *vacua Interstitia*, which have no resistance against it, than it would or could force its room upon the ambient Vessel that containes it, and resists its dilatation with all the strength it hath. And this very reason doth as effectually conclude against the second *Solution* of *Rarefaction* by the admission of *Materia Subtilis* into the supposed *Interstitia*, if duly considered,

CHAP.

CHAP. VII.

Concerning the Second Solution of Rarefaction *and* Condenſation, *and its inſufficiency.*

I Come in the next place to conſider the ſecond Solution above offered; which ſuppoſeth theſe things.

1. That there is no empty ſpace or interſperſed vacuity in the Air or any part of the Univerſe; with which I agree.

2. That the Principles of compounded bodies are certain minute Atomical Corpuſcles, phyſically indiviſible; and yet for all this, theſe very minute bodies are ſome groſſer, like little *Globuli*, ground to as ſmall a magnitude as is naturally poſſible; and yet the *Ramenta* or Filings of theſe *Globuli* are ſmaller than the former, and make that Conſtituent or Principle which they call *Materiâ ſubtili*,

tilis, which interpoſeth between other groſſer Atoms or Corpuſcles, and filleth up the *Interſtitia* between them; this Suppoſition I deny, and ſhall ſhew my Reaſons againſt it.

3. That in *Rarefaction* or Tenſion of the Air, or other Bodies capable of *Rarefaction*, there is only a ſeparation or disjunction of the parts thereof to a greater diſtance one from another, which doth not at all encreaſe its extenſion, but only varies the poſition or vicinity of its parts; and hereupon to fill the *Interſtitia* between the parts thus divulſed, there is immitted into thoſe *Interſtitia* ſubtil matter, or thoſe ſubtil Filings of the *Globuli* that fill thoſe ſpaces which are therefore borrowed from the ſubtil matter of the other parts of circumjacent Air; or finally from the *Æther*, which ſeems to be the ſubtileſt matter in Nature.

4. That in Condenſation of the Air, *&c.* by compreſſion that *Subtiliſſima Materia* that reſided before within the body of that portion of Air, is

is by compreſſion ſqueezed out, and driven into the conterminous Air, whereby that which we call the condenſed portion of Air and its parts come cloſer together, and take up leſs room or ſpace than it ſeemed to have before; namely, in the external bulk or *Superficies*, though in truth and reality the Air it ſelf thus ſeemingly condenſed, and its particles, take up really as much room or ſpace as before, though the figure, and poſition, and ubication of that ſpace that it takes up now, is only altered by its receſſion into the ſpaces wherein the *ſubtiliſſima materia* now flown away, did formerly reſide.

This Solution of *Rarefaction* and *Condenſation*, I think is neither true, nor doth it in any meaſure anſwer the *Phænomena* in *Rarefaction* or *Condenſation*.

Firſt therefore, I think the very Suppoſition it ſelf of theſe ſolute Atoms is but imaginary and the creature of the Brain, and therefore I think may deſerve the Title of *Idolum*

lum Epicureum, or *Carteſianum*, never intended by the latter as any real Truth, but only as a Suppoſition, Engin or *Medium* to explicate the *Phænomena* of Nature, though now unwarily enough taken up by many *Virtuoſi* as a Truth.

1. It robs all bodies of any real or poſſible continuity without a miracle, or the ſubſtitution of ſome cementing matter, differing from Atoms or ſolute bodies, to hold the parts of the Univerſe together; for how can really ſeparate bodies, ſuch as the very leaſt of Atoms are ſuppoſed to be, have any continuity, or ſo much as mutual coheſion barely by contiguity? For as to the *Atomi hamatæ*, they ſavour too rankly of fiction and invention, and the Polar Magnetiſm and difference of Sexes of Atoms ſeems as vain.

2. We ſee in many bodies not only a continuity, but a ſtrong texture, whereby they will not readily be broken, that yet at firſt ariſe from a thin watry ſubſtance or concrement, as the

Nerves

Nerves of Animals, the Wood of Trees, the Barks of Trees and Plants; as *withy*, *Flax*, *Nettles*, nay the very *Spiders Web*, hath beſides its continuity, a certain tenaciouſneſs; ſo hath *Water* it ſelf, as appears by the traction of the water in the longer Leg of a *Siphon*; this tenaciouſneſs, glutinouſneſs, and ſtrong coheſion of parts of bodies one to another, could never be by the appoſition of ſolute particles one to another, though never ſo ſmall, but from a kind of intrinſick contexture of the bodies themſelves.

2. Upon this Suppoſition, it were neceſſary that all bodies ſhould be equally hard, and equally weighty, and equally denſe. Thoſe Atoms, even thoſe that are the moſt minute, that are the Conſtituents of the *Materia ſubtiliſſima*, are yet ſuppoſed to be bodies, and eſſentially diviſible, though not divided, nor indeed diviſible phyſically by any force, and therefore hard and unfrangible; and therefore, if we ſhould take a Veſſel

of a foot ſquare filled with Air, this *Moles*, though we call it of Air, is yet really made up of thoſe hard particles, and then how is it poſſible it ſhould be ſoft to the touch any more than Braſs or Steel? For the ſoftneſs of duſt of Gold or other ſolid Bodies, is not from the duſt it ſelf, but from the numerous interſperſed particles of Air. Again this Cubique Veſſel full of Air is entirely full of body, or not; if it be not, then this ſuppoſition muſt neceſſarily admit interſperſed Vacuities; the thing that the whole Suppoſition of the *Carteſians* deny: But if it be full of body in every imaginable ſpace thereof, why ſhould not this Cubique *Moles* of Air thus conſtipated with a plenitude of body, be as weighty as the like Cube of water, yea, or Gold; for as to ſolidity, the Atomical bodies themſelves in both, are of the ſame conſiſtence, and all ſpaces are ſuppoſed full both in the Cubique foot of Air and Water, for excels of weight, is but the effect of excels of Matter or bodily ſubſtance.

4. Again,

4. Again, It is moſt certain that the ſmalleſt Atoms or Particles of matter, even the *Ramenta* that are ſuppoſed the Conſtituents of the *Materia ſubtiliſſima*, are yet bodies, and conſequently have their *Trina Dimenſio*, and variety of configurations; ſome ſpherical, ſome cubical, ſome triangular; be theſe never ſo little, yet it is impoſſible they can exactly touch one another in all parts of their *Superficies*; a ſpherical body cannot be in all its *Superficies* contiguous to another ſpherical or cubical body; and conſequently there muſt be ſome real, though ſmall Intervals between theſe minute Particles, and then the *Carteſians*, to make good their Suppoſition, muſt have yet another matter more ſubtil than that which they yet call *ſubtiliſſima*, to fill thoſe Chinks: *Et quis cuſtodiet ipſos Cuſtodes?*

And it is not enough to ſay theſe fiſſures between the minuteſt Particles, are inconſiderable: For if they be at all, it ſpoiles the Suppoſition; but beſides that, certainly he that holds

holds this Suppoſition, muſt yet admit that in the Cubique Foot of Air, the *Interſtitia* muſt needs be greater than in Water or *Mercury* of the like *Moles*; for certainly otherwiſe the weight of *Mercury*, Water and Air, would be all one; and ſo they fall in with the *Vacuiſts*.

Therefore upon the whole Matter, it ſeems more agreeable both to Nature, Senſe and Reaſon, that in the firſt production of bodies homogeneal, whether by Creation by Almighty God, or by Generation, according to his inſtituted Law of Nature, the conſiſtency of things, and their ſeveral textures, to be the immediate effect of their firſt production, and that they conſiſt of parts in union, and not ſeparated till actual ſeparation, and that theſe parts are of the like conſiſtence and texture with the whole in bodies homogeneal, as in Air and in Water, and not of parts or principles quite of another conſiſtence and frame from the whole; all the parts of the Air to be Air; but

yet

yet ſome Air or Airs at ſome times more ſubtil than others; and ſo for Water: And therefore all this *Apparatus* of Atoms, and *Globuli*, and minute particles, are not of things that ever really exiſted, but only the creatures and fictions of the Brain.

But if we ſhould admit of any one common material principle of phyſical bodies, it is moſt conſonant both to the Doctrine of the Scriptures, and to ſome of the ancient Philoſophers, that it ſhould be Water.

1. Thus it is declared in that admirable Narrative of the Creation, the firſt diſtinct body we find mentioned, is the Water.

2. This was the opinion of the Learned *Thales*, *Mileſius*, and others of the Ancients, *Ex Aqua omnia.*

3. The accommodation of Water to the production of other bodies by the tranſmutation of its texture, ſpeaks much for it to be the common principle of material bodies.

1. It is productive of Conſiſtences rarer and more ſubtil than it ſelf, as

Va-

Vapours, Fumes; yea and of the very Air it ſelf, by the means of activity of Heat.

2. It is productive of things more craſs and ſolid than it ſelf, as *Leaves*, *Fruit*, *Wood*, *Shells*, *Stones*, which we ſee ariſe from certain concretions ſingly of water.

3. It is productive of conſiſtences that have greater tenaciouſneſs and connexion than it ſelf; as we ſee in the production of the *Nerves*, *Tunicles*, *Tendons*, *Muſcles* of Animals, which are at firſt but certain wateriſh concrements, digeſted by the Animal heat into thoſe Ligaments, and in the tough and ſtrong barks and filaments of Vegetables, in their trunks, rinds, *&c.* which are at firſt but a kind of limpid juice or water ſucked up into the bodies of Vegetables; and that even where it hath no other viſible nutriment but ſimple Water.

4. In the diſſolution of bodies, either artificially or naturally, they ſeem moſt readily to reaſſume a wateriſh

teriſh Conſiſtence: Water therefore ſeems more accommodate to be the common material principle, much rather than theſe imaginable Atoms; though I take not upon me poſitively to determine it.

Chap. VIII.

Further Conſiderations concerning the deficiency of this ſecond Solution *in relation to* Rarefaction *and* Condenſation, *and the Supplements that have been deviſed to enforce or ſupply it.*

IN the laſt Chapter I have conſidered the improbability of the Suppoſition in general.

I ſhall now ſet down thoſe Reaſons and Evidences which render the whole Suppoſition utterly inapplicable to the *Phænomena* of *Rarefaction* and *Condenſation.*

1. As

1. As to *Rarefaction*, the intromission of these foreign particles of Matter, to supply the supposed separation of the particles of the Air, or other body rarefied, it is not possibly consistent with that motion which rarefied bodies have in the time of their rarefaction, which is most apparently expulsive of any foreign Matter, and not receptive of it.

Take a Corn of Gunpowder, and give it fire, it turns in a moment to a body of flame above 1000 times larger than it self, it drives away the conterminous Air from it; and if it be a good quantity of Powder, it will break the Windows, Walls and Contignations next to it, and this done in a moment, and in the moment of its expansion: Is it imaginable to any man that thinks twice, that in that moment of its expansion, when it drives all before it and from it, this *Subtilissima Materia*, which is so subtil and delicate, should have admission, and admission in that moment, to make good an expansion of such

ſuch an extent, nature and quality?

Again, When Air in a Veſſel, is brought near the fire, and warmed by this Heat, the Air is expanded, and a great part of it driven out of the Veſſel; and if the Veſſel be cloſe, it will break, from the dilatation within; ſo that in all this rarefaction, the Air, and all the particles of it, and within it, have a preſſure outward, not any motion of receptiveneſs of any thing from without, and therefore muſt neceſſarily drive away thoſe gentle particles of *Materia ſubtiliſſima*, and can never admit them in the act of rarefaction done by Heat.

2. It is a very hard ſuppoſal that the ſubtil Matter ſhould paſs through the moſt impervious bodies, as *Glaſs*, *Braſs*, yea *Gold* it ſelf, for the ſupplying of the *Interſtitia* of tenſe or rarefied bodies, as it muſt according to this Suppoſition. But,

3. It is not only difficult to believe it, but the contrary thereof is moſt apparently evident to the very Senſe, eſpecially in the *Magdeburg Hemiſpheres*,

ſpheres, deſcribed, *cap.* 18. *Nugarum*: If you take the two Braſs Hemiſpheres there deſcribed; and by heat rarefie the Air in them, then clap them together in the manner there deſcribed, when the included heat is ſpent, they will cohere ſo ſtrong together, that 30 *l.* weight will not ſever them, but let them receive a moderate heat again from the fire, or let there be a hole no bigger than the point of a Needle to let in any foreign Air, they will be quickly ſevered; for the tenſion which the included particles of Air do gain by their motion of reſtitution, and *Motus nexus*, is thereby relaxed: And it is obſervable, that theſe *Hemiſpheres*, if they are kept from heat or perforation, they will remain in this poſture of coheſion an hour, nay poſſibly a day, or week, or more: Now if this ſubtil matter, which muſt be the means of *Rarefaction*, or extenſion, according to the *Carteſian* Suppoſition, pervades the Veſſel ſo eaſily, how comes it to paſs that it is kept in this

this ſtraight priſon without avolation through the Braſs *Hemiſpheres*? Or rather, why doth not a greater quantity thereof pervade the Braſs *Hemiſphere* all this while, and releaſe the Air from its hard tenſion, by ſeparating thereby the *Hemiſpheres*, and ſo reſtoring the Air in all parts to its juſt and natural texture and poſition? And certainly if the Spirit of Nature or *Hylarchical Principle* had any thing to do in matters of this Nature, or were effective in it, here were a proper buſineſs and exerciſe for it; But we ſee that without perforation or acceſſion of Heat, nothing of ſuch relaxation is effected, notwitſtanding the great ſtreſs that the Air is under in the *Hemiſpheres*, and which yet would be inevitably relaxed, if a conſiderable portion of ſubtil Matter did penetrate through the *Hemiſpheres*, and mix it ſelf with the included rarefied Air, as well as if a little Air were let into it through a Pin-hole.

4. In the Inſtance laſt given, and many other of like nature, that might

be given, where the filaments of the Air in their relaxation from heat, have a motion of contraction in themſelves *per viam reſtitutionis*, and a conſequential attraction on the Veſſel including them *per modum nexus*, it is impoſſible this can be ſalved by the Suppoſition of the *Carteſians* and *Lucretians*, which ſuppoſe the Air to conſiſt of minute particles only joyned together by contiguity, for where there is only contiguity without continuity of parts, that body can never draw another body *per modum tractionis*, it will be really leſs tenacious than a Rope of Sand; ſo that ſuch an intromiſſion of particles thus ſolute, as they ſtate moſt bodies to be, by a bare contiguity of Atoms, could never explicate this viſible *Phænomenon* that enſues upon tenſion of the Air, or after, the avolation or extinguiſhment of Heat that firſt expanded it.

5. And as this Suppoſition by no means ſalves the *Phænomena* of *Rarefaction* of the Air, and what enſues there-

thereupon, ſo it as little ſalves that of *Condenſation* or Conſtipation of Air by compreſſion, as we ſee in *Wind-Guns*, and other Engines, which upon a Diſcharge, or a Motion of that compreſſion, do with a force explode or diſcharge themſelves, and preſs very hard upon bodies that are in their way; ſo that a *Wind-Gun* will drive a Bullet through a pretty thick piece of Wood, which could never be, if this Solution of *Rarefaction* and *Condenſation* were true.

1. If the Air it ſelf, and alſo this ſubſidiary *Materia ſubtiliſſima* were but a collection of minute bodies, joyned only in contiguity one to another, all the compreſſion in the world would give it no more elaſticity, or that exploſive motion, than if a portion of *Calice-Sand* were forced into a Gun or other Veſſel, with all the compreſſion imaginable.

2. But again, in that elaſtical exploſion by the Air compreſſed into a narrower room, what is it that actually exerciſeth that exploſive Elaſti-

city? Is it the ſubtil matter that was mingled with the included compreſſed Air? Surely no; for according to this Suppoſition, that is ſqueezed out and permeated through the Barrel or Trunk of the *Wind-gun*: Or is it the groſſer Particles of the Air that is yet left in the Gun, and cannot get out till the *Obturaculum* be removed? But there is no reaſon for that to have any Elaſticity; for by the avolation of the ſubtil Matter, there is room enough left for it; and under that narrow dimenſion that now it hath, yet hath it as much room as before; for the avolation of the *Materia ſubtilis* hath made a perfect room for it, and left it a ſpace exactly commenſurate to its corporeal *Moles*. But it may be that the *Materia ſubtilis* that was driven out by the compreſſion, now upon the aperture of the *Obturaculum*, pervades the ſubſtance of the Gun with that force that it gives the exploſion. But it is apparent that neither this can help it; for it doth appear that the Motion

tion of the Subtil Matter into the Orifice of the *Wind-gun* upon the removal of the *Obturaculum* muſt needs run counter to the exploſion of the Air, and obſtruct it. Again, it is apparent that the ſubtil Matter is driven out gradually and with iterated force, and it cannot pervade the Iron ſides of the Gun, but gradually, and with great ſtraining, and to imagine that in a moment, the moment of a Motion of the *Obturaculum*, the whole body of that removed Matter ſhould pervade the ſtrong and cloſe Metal in an inſtant to give that ſtrong and forcible exploſion, exceeds all reaſon, ſenſe and credibility. And therefore it was but neceſſary for thoſe that will maintain this Aſſertion to ſubſtitute a Spirit of Nature, or an *Hylarchical Principle*, which for the preſervation of Bodies in their due natural ſtate and poſition, ſhould act little leſs than miraculouſly to ſupply all theſe Difficulties, which yet notwithſtanding muſt be ſuppoſed according to this Suppoſition to act in contradi-

ction to it ſelf and Nature alſo. For when in *Rarefaction* of Bodies this *Spiritus Naturæ* ſends ſupplies of ſubtil Matter to fill the *Interſtitia*, it muſt neceſſarily rob other parts of the Air of ſome of that ſubtil Matter that properly belonged to its texture and natural conſtitution; and ſo when one portion of Matter is gratified, another is impoveriſhed of what belongs to it, which ſeems wholly unſutable to the office which this vicarious Spirit of Nature (according to this new Suppoſition) is ſubſtituted to exerciſe.

CHAP.

Chap. IX.

Touching the Third Suppoſition of the Method of Rarefaction *and* Condenſation *according to the Ancient Philoſophy, and ſeems to be the trueſt.*

HAving examined the two former Suppoſitions, and as near as I can, diſcovered their inſufficiency, I now come to the Third, which I think to be true, *viz.* as to that kind of *Rarefaction* and *Condenſation* (which before in the 4th Chapter is ſtated to be the true Matter of the Queſtion) for in *Rarefaction* of a Body (ſuppoſe Air) either by Heat or Tenſion, there is a real expanſion or dilatation of the ſame *Moles* of Matter of the Air, and all its parts to a larger ſpace, extent or dimenſion than it had before; and in *Condenſation*, by Cold,

(but more evidently by compreſſion) the ſame *Moles* of Matter, and all its parts have a narrower or leſs ſpace or expanſion than before.

I ſuppoſe therefore that although *Rarefaction* and *Condenſation* of any Body from its natural ſize and dimenſion belonging to it, is for the moſt part, if not alwayes, by the agency or efficiency of ſome external cauſe, yet under ſuch circumſtances: *Rarity* and *Denſity* are but natural affections, or rather Paſſions, Qualities or Modes of ſuch Bodies ariſing from their very texture and make, and are as naturally belonging to them as Heat or Cold, Humidity or Drineſs, Smoothneſs or Roughneſs, or other tangible Qualities to other Bodies that are more groſs and corporeal.

2. I do ſuppoſe that whatever men have talkt or wrote concerning *Spatia imaginaria*, without relation to any Bodies to fill it, yet as time or ſucceſſive duration is a kind of Attendant upon ſucceſſive Motion, ſo ſpace is a kind of Entity relative to Bodies, and dependent upon them. 3. To

3. To make way to what I have to ſay herein: It ſeems to me no kind of repugnancy in Nature, but altogether conſonant thereunto, and that it is equally poſſible and reaſonable that a Body that is much more rare than another, and having in it leſs of ſolid corporeity, and conſequently of weight, than another, yet may as entirely fill the whole ſpace within the compaſs of its external *Superficies*, as a body of a denſer conſiſtence, ſo that although Gold be 18000 times bulk for bulk heavier than Air, and near 20 times heavier than Water; and although Water be near 14 times lighter than *Mercury*, yet it is no way repugnant, but highly conſonant to Nature, that all the particles of a Cube of Air may be as cloſely united one to another, and as entirely fill that Cubical ſpace, as the like Cubical body of Water or *Mercury*, or Gold: And that although it is inherent in the very nature of a rare body, not to have ſo firm a conſiſtency as that which is more craſs

and

and ſolid; yet ſuch a rare body may be wholly deſtitute of Pores or *Interſtitia* between its parts, as the moſt ſolid body imaginable; for poroſity or diſtance of parts is not an effect neceſſarily reſulting from Rarity. For it would be a ſtrange poſition, that no Body that were not *ſummè ſolidum* or *craſſum*, could have been created, that had all its parts commenſurate to all the ſpace within the external dimenſions, or *extima Superficies* of ſuch body, and yet this muſt neceſſarily follow, if ſuch a commenſuration *ex naturarei*, were contradictory to, and inconſiſtent with any body that is not *ſummè ſolidum* or *craſſum*, whereof poſſibly there is no inſtance that is or can be made; for Gold it ſelf is not *ſummè craſſum* or *ſolidum*; for one piece of Gold may be ſolider, and have more of craſs Matter than another: which appears by the Diſparity of weight between two ſeveral kinds of Gold of the ſame bulk.

Nay, upon a ſtrict ſearch it may be found *de facto* true, that ſome kinds

kinds of Wood or Metals that are more craſs, and conſequently more weighty than others, may yet be more porous than ſome Woods or Metals that are lighter and of a greater tenuity; yea, Glaſs or Cryſtal, that is lighter and leſs craſs than ſome other bodies, may be leſs porous than ſuch as are heavier and craſſer; or if compariſon be made between it and common Iron-Ore, the like between *Calice-Sand* and yellow Wax, and many more, whereof the Table of the Lord *Verulam*, in his *Hiſtoria Denſi & Rari*, may yield us many Inſtances.

Again, we have no better meaſure of the Rarity or Denſity in Bodies than their difference of weight, *Quod Rarum, leve; quod Denſum, grave.* Let us reſume the Inſtance given *ſupra, cap. 6.* Wherein it appears that Air is at leaſt 12000 times lighter; and conſequently rarer than *Mercury:* Now if we ſhould ſuppoſe the Air in a Cubique Veſſel of a Foot ſquare, ſhould fill but $\frac{1}{12000}$ of that ſpace,

and

and the reſt, *viz.* 11999 parts of that ſpace muſt be either totally empty, or ſupplied with another kind of Heterogeneous ſubtil Matter, differing from Air: This muſt be the conſequence of the Suppoſition that the *Moles aeris* is not commenſurate to all the ſpaces within the Cavity of that Cube, and yet it is ſo evidently againſt Senſe, that it is not poſſible to be admitted, or almoſt conceivable by any that duly thinks of it.

Water is ſubtiler than *Mercury*, by 14 times; Air is ſubtiler than Water by 900 times; and poſſibly the *Æther* above the *Atmoſphere*, or the *Elementa Stellarum* is as much ſubtiler than common Air of our lower *Atmoſphere*. It were a wild conceit to think that every given portion of the Ethereal world muſt neceſſarily have forty thouſand equal portions, either of Vacuity, or of ſubtil Matter, more refined than *Æther*, and that no one given portion of *Ethereal* Matter; ſuppoſe a Cubique Foot could be

be exactly commenſurate to all the ſpace within that Cubique Foot, but muſt have forty thouſand interſperſed pores, either wholly vacant, or filled with another more ſubtil Matter than it ſelf.

I conclude therefore, it is equally conſonant to the nature of Bodies, that a more rare or ſubtil Body may be, and is equally commenſurate to all the ſpaces within the extent of its Ubication, as the craſſeſt body in the World.

The thing I drive at is this real Truth, *viz.* that a Body though never ſo rare, may be entirely commenſurate to all the ſpace within the compaſs of its external *Superficies*, as well as the denſeſt or craſſeſt Body that is or can be in Nature; and conſequently that the ſame Body, if it have at ſeveral times ſeveral textures, may in theſe ſeveral ſeaſons entirely poſſeſs ſpaces anſwering ſuch textures; as, if Water gain the texture of Air, it may be commenſurate to all ſpaces within its *Superficies*.

4. It

4. It ſeems to me, that although ſome particles of Air included in the common Body of the Air, may poſſibly be more ſubtil than others, yet as to point of extenſion or contraction, all the parts thereof, even the minuteſt parts thereof, as to the quality of Rarity and Tenuity, and the motion of *Rarefaction* and *Condenſation*, are of the ſame nature, and perfectly homogeneal; and the like for Water; and although ſome imaginable parts thereof may be rarer, others craſſer, yet they are perfectly mingled together, as common Conſtituents of the ſame Body we call Air; and therefore to ſuppoſe the firſt Conſtituent minute particles of Air or Water, are hard, or of any other nature than the whole Body, is a precarious, inevident and unreaſonable Suppoſition.

5. I do ſuppoſe it as a certain, evident truth, that the ~~actual~~ exiſtence of parts or particles of continued Bodies (as moſt evidently Water and Air are) are but only potentially, or by the operations of the Under-

Underſtanding in ſuch Bodies, and not really exiſting, as parts, or as divided, till a real and actual ſeparation of them with integral parts, though they may be bigger or leſs, according to the method of their ſeparation; yet,

1. Still remain Bodies.

2. Cannot be indiviſible, no not phyſically.

3. Are of the very ſame nature, texture or make with the whole Body out of which they are cantelled; and therefore when the external *Superficies* of the whole bulk in *Rarefaction* is expanded, or in *Condenſation* is contracted, the like expanſion and contraction happens in proportion in every particle thereof, in a true and proper *Rarefaction* or *Condenſation*, whereof the Queſtion is ſtated.

6. I do not think that corporeity or bodily conſiſtence is the ſame thing with quantity or *trina dimenſio*; but that this is but an affection or conſequence of it; for otherwiſe all Bodies that have an equal *trina dimenſio*, muſt

muſt needs have the ſame Denſity; or an equal maſs of Matter, or Corporeal *Moles*, which is contrary to Experience; for a Cubique Foot of Water hath leſs of Matter than a Cubique Foot of *Mercury*, as appears by the diſparity of their weight, the beſt indication of the diſparity of the *Moles* of Matter.

Theſe things being thus premiſed, I now proceed to declare my thoughts touching *Rarefaction* and *Condenſation*, holding my ſelf ſingly to it as it is ſtated, to be the Queſtion in the 4th Chapter, and principally applying my ſelf to thoſe Bodies that are moſt *Pneumatical* or Spirital (I ſay not Spiritual.)

It ſeems therefore to me, that as ſeveral Bodies of the ſame external extent or *Superficies*; as, ſuppoſe a Cubical Foot of Air, Water, *Mercury*, or Gold, may have, and have yet a cloſe continuity of all their particles without any *Interſtitia* of vacuous ſpaces, or of other Matter, to fill them up, and all this ariſing from the various

various textures of thoſe bodies, ſo the ſame body by a various texture acquired by accidental emergencies either of heat, tenſion or compreſſion, may acquire a greater or leſs expanſion, according to thoſe varieties of acquired textures, yet without any new acceſſion of ſubſtance, or deperdition of any its included particles, but ſtill remaining individually the very ſame Matter.

For if ſeveral bodies of various textures, may be ſome more rare, and ſome more denſe, from their very Make and texture, and yet as well thoſe that are more rare, as ſuppoſe Air or Water may as exactly fill all the ſpaces within the compaſs of their extenſion, without the ſubſidiary help of vacuities or other interſperſed bodies, as well as thoſe of a more condenſe conſiſtency; ſuppoſe Gold, Lead: or *Mercury*; the very ſame reaſon doth enforce that the ſame body, if its texture be either by force or accident, altered to a greater Rarity or Denſity than it had before, may alter its

ſpace, and yet be entirely and exactly commenſurate to a greater or leſſer ſpace, according to ſuch alteration of its texture, as well as thoſe ſeveral bodies that had primitively the like variety of texture conſtant to their nature.

For Matter or material ſubſtance is of it ſelf equally ſuſceptive of a laxer or craſſer, a rarer or denſer conſiſtence or texture of parts; only when it is lax or rare, the ſame portion of Matter takes up more ſpace; when it is craſs or denſe; it takes up leſs ſpace.

For inſtance, in Diſtillation we will ſuppoſe that firſt by ſome moderate Heat the diſtillatory Veſſels, the Veſſel (wherein the Roſes for the purpoſe are placed to be diſtilled) the Head of the Still, and the Recipient to be as much evacuated of Air, or the included Air attenuated as much as may be, and then the Veſſels cloſely luted one to another, the moiſt Matter of the Roſes by gentle heat is reſolved firſt into a ſubtil Fume or Vapour,

Vapour, and ſo rarefied from what it was in the Roſe-Leaves: Then again theſe Fumes or Vapors partly by the coldneſs of the Head of the Still, partly by the collection and aggregation of the Vapors themſelves, reſolve into drops of water, and ſo diſcharge themſelves into the Receivers: Here the very ſame body by the change of its texture, namely, the watry or moiſt ſubſtance of the Roſes is firſt dilated into Fumes or Vapors, and then contracted into Water; and the firſt receive a dilatation or expanſion into Vapors, where it takes up a larger dimenſion in all its parts, as well as in its ambient *Superficies*, and then a contraction into a narrower compaſs, when reſolved into Water, and yet continues ſtill the ſame body; but by variation of its textures, aſſumes a larger or narrower dimenſion in all its parts without reception of new foreign particles to dilate it, or emiſſion of ſome of its ſubſtance in contraction or condenſation.

Which Inſtance explains what I intend; namely, that the ſame individual body, according to the variety of its textures, may acquire a larger or leſs ſpace, and yet continue the ſame body, though altered in the textures of *Rarity* or *Denſity*; as Air hath a larger expanſion than Water, ſo if Water be converted into Air, and thereby its texture altered into a more ſubtil expanſive body, it takes up the ſame dimenſion as if it had been never Water, but alwayes Air. And if Air again be converted into Water, it takes up the ſame contracted dimenſion, as if it had ever been Water.

And this method of ſolution of *Condenſation* and *Rarefaction*, anſwers all the evident, apparent and ſenſible *Phænomena* in *Rarefaction* and *Condenſation* above delivered, and that without any difficulty or ſtrained ſuppoſition: For inſtance, In Rarefaction by Heat, or by tenſion of a Cubical Foot of Air in a Veſſel, it is viſible that the Air, and every particle of it, gains

gains a larger extent every way; for it will break the Veſſel, unleſs it have vent, which it could not do, unleſs the entire body were extended, and not barely the *Superficies*, becauſe unleſs the whole *Moles* were every way expanded, it would have room enough within it ſelf for its reception without breaking the Veſſel that contains it.

Again, when the Heat decays, and conſequently the Air relaxed from that extent, it endeavours its own contraction to its juſt and natural ſize and texture which it loſt for the time, by the foreign violence of expanſion by Heat or Tenſion, and this by a natural motion of reſtitution to its natural texture; and becauſe it cannot gain its relaxation to its former texture by contraction, by reaſon of the vacuity that would thereupon follow, it doth as much as it may, and lays hold on the internal ſides of the Veſſels wherein it is impriſoned, and pulls them together; but as ſoon as it gains a relaxation by the admiſ-

ſion of foreign Air into it, the very ſame portion of expanded Air that under its expanſion filled a Cube of a Foot ſquare, will ſubſide into a ſpace of leſs than ſix inches ſquare, which was its true natural ſpace reſulting from the texture it then had, by that admiſſion of foreign Air.

Again, in *Condenſation* a portion of Air, ſuppoſe a Cubique Foot in its juſt and natural texture, entirely fills all the ſpace within that Cubical Foot (for its texture is ſuited to ſuch a ſpace) but being compreſſed forcibly into a *Wind-gun* or *Æolipile*, the texture is changed by this violence, and it takes up perchance not the twentieth part of that ſpace: The difference of its extenſion ariſeth from the alteration of its texture by this external compreſſive force uſed upon it; and hereupon it gains an Elaſticity, which is nothing elſe but a natural motion or *conatus* to be reſtored to its former juſt and natural texture, and conſequently to that juſt extent, and Liberty, and poſition of ſpace that belongs naturally

rally to it, as a Stick, or Branch of a Tree, or Spring of Steel being bent beyond, or againſt its juſt poſition, hath its motion of reſtitution to its former poſition, with a force or reſilition: For the Air in its natural conſtitution, hath a certain determinate texture belonging to it, and conſequently a juſt and natural extenſion proportionate to that texture. And this it greedily endeavours to keep; and when diſturbed from it, to re-acquire, which is the motion of reſtitution which I often expreſs by the natural and ſpontaneous contraction of a Lute-ſtring, after an extention beyond its proper texture. And this is the genuine and true cauſe of that ſtrong and violent exploſion that happens in thoſe *Pneumatical* Engins of various ſorts.

So that in theſe and all other *Phænomena* of *Rarefaction* and *Condenſation*, this plain, and common, and ancient Solution ſquares exactly with them, as might be inſtanced in infinite more Particulars, if it were needful.

And with this agree the beſt Philoſophers both Ancient and Modern.

Ariſtotle, that great Prieſt of Nature, in 4 *Phyſicor.* cap. 9. wherein he anſwers the Objections brought by others to prove Vacuities from the *Phanomena* in *Rarefaction* and *Condenſation*, tells us that *Rarity* and *Denſity* properly ſo called, are not by acceſſion of new Matter, or loſs of any of the old, but from the potentiality of Matter it ſelf, to undergo ſeveral textures, and conſequently ſeveral extenſions, *Si factus eſt Aer ex Aqua, eadem materia facta eſt Aer, nulla re inſuper alia aſſumpta ſed quod erat potentia, id tandem facta eſt actu; & ſimili modo ſi orta eſt Aqua ex Aere, eadem namque materia nunc in magnam ex parva, nunc in parvam ex magna vertitur molem*, &c. *Qua re ipſa Moles ſenſibilis non ideo extenditur aut conſtringitur quia materiæ aliquid inſuper adjicit aut objicit, ſed quia ipſa Materies utrumque ſubire poteſt, quo fit ut idem ſit rarum & denſum, & utriuſque Materia una, atqui*

atqui denſum eſt grave, rarum autem leve.

Again, the Lord *Verulam*, a great inquiſitor into Nature, and not very friendly to *Ariſtotle* in his *Hiſtoria Denſi & Rari*, after ſeveral Inſtances of *Pſeudo-rarefactions*, when he ſpeaks of *Rarefaction* of Air by Heat, *pag.* 43. tells us, *Aer per calorem dilatatur ſimpliciter, neque enim ſeparatur quippiam, aut emittitur, ut in tangibilibus, ſed ſimpliciter fit expanſio.*

This *Rarefaction* is not therefore by the diſtraction of the particles of Air one from another to a greater diſtance, and interpoſing poroſities or *interſtitia* either of perfect empty ſpaces as the *Vacuiſts* would have it, or filled with adventitious ſubtil Matter, as the *Carteſians* would have it; neither in *Condenſation* are any parts of Air, or included in Air drawn out, and thereby the remaining particles rendred into a cloſer order and contiguity one to another:

But in the former the extenſion of the whole portion of Air, and of every

every particle is thereof *quaquaverſum* enlarged, and in *Condenſation* the entire extenſion of the Air and every part thereof is *quaquaverſum* contracted, and this variation is no other but a common affection, or rather poſition or quantity of Matter neceſſarily ariſing from the various textures that it ſucceſſively acquires.

And therefore the great Objections that are made againſt this Method of the Ancients in their accounts of *Rarefaction* and *Condenſation*, fall to juſt nothing; as for inſtance,

1. That in *Rarefaction* of the Air it muſt be ſofter to the touch, and in *Condenſation* harder: I would gladly hear of that man that ever knew *de facto* Air condenſed but to its 100th part yet if it were condenſed 900 times, it would not be ſo denſe as Water, or what diſproportion to the touch he can find between Smoke and Air, and yet the former is far more denſe; for it is conſpicuous to the view: ſo that he had need be a man of exquiſite ſenſe, to make any concluſion from his touch,

touch, touching the *Rarity* and *Denſity* of a *Pneumatical* Body.

Again, if the Atomical *Hypotheſis* were admitted, it is not conceptible but that all bodies, whether in their natural texture, or under the motions of *Rarefaction* and *Condenſation*, muſt be hard and equally hard, becauſe conſiſting of a plenitude of Atoms, which are all ſuppoſed to be hard and infrangible.

CHAP.

Chap. X.

A farther Conſideration of Rarefaction *and* Condenſation, *and of the Suppoſition of the penetrability or impenetrability of Bodies, Material Subſtances, Quantity, Extenſion,* &c.

THe principal Objection againſt the method of *Rarefaction* and *Condenſation*, propounded in the former Chapter, is this, That it is impoſſible the ſame *Moles* of Matter can aſſume a larger ſpace and dimenſion, as in *Rarefaction*, without a diviſion of one part from another, and thereby leaving certain vacant *Interſtitia* between the parts ſeparated, or without a ſuppoſition of a pre-exiſtent penetration of the parts of Matter, while in its former more condenſed conſiſtence

ſtence, and in *Rarefaction* thruſting out thoſe parts that formerly penetrated one another, being unfettered in *Rarefaction*, or by admiſſion of new poroſities made in the rarefied Matter, and reception therein of other foreign Matter. Again, *Condenſation* of the ſame portion of Matter cannot be without ſuppoſition of vacant empty *Spatiola*, which are cloſed up by the ſtrict coalition of parts, or by ſuppoſing a penetrability and penetration of the parts of the ſame portion of Matter in its new acquired ſtate of *Condenſation*, or by driving out from that portion of Matter ſome of its more ſubtil parts, whereby the remaining parts are fewer, and take up leſs room or ſpace than before ſuch *Condenſation*: The firſt is the firſt way propounded by the *Vacuiſts*, and is rejected. The ſecond is in effect the way propounded by me in the former Chapter, but is ſaid to be inconſiſtent in nature, becauſe penetrability of bodies or of extenſion of Material Subſtance, is rejected by almoſt all Phi-

Philoſophers; therefore the laſt, which is the middle way, contended againſt in the 8th Chapter, muſt be the true Method of *Rarefaction* and *Condenſation.*

I anſwer, It is true, I have laid aſide, and that juſtly, the Opinion of the *Vacuiſts*, in the 7th Chapter, and likewiſe the Opinion of acqueſt of new Matter, and expulſion of part of the old, in the 8th Chapter, and have entertain'd the Opinion of the Ancient and ſome of the Modern Philoſophers, in the 9th Chapter. And it is true that this Opinion thus by me entertained, cannot well be ſupported without a ſuppoſition of the penetrability of material Subſtances, or ſomewhat analogal thereunto, *viz.* Contraction and Dilatation: And it is true, that although I think that this penetrability of Material Subſtance, be a great truth, yet it is ſome difficulty to explain it; which nevertheleſs I ſhall endeavour to do; and in doing of it, the Anſwer to the Objection will evidence it ſelf. And I

ſhall

ſhall chooſe to do it this way, namely, by explication of Terms and Words, and rendring my apprehenſions ſutable to thoſe Explications, though it may be in a different manner from the uſual or Scholaſtick expreſſions.

1. Concerning Penetrability and Impenetrability.

2. Concerning Material Subſtance.

3. Concerning Body, and wherein it differs from the Notion of Subſtance.

4. Concerning Quantity.

5. Concerning Rarity and Denſity.

6. Concerning Extenſion or Dimenſion.

7. Concerning Penetrability, how it is or is not applicable to the former Subjects.

Firſt, Penetrability or Penetration of Matter or Bodies, *&c.* is of three ſorts, *viz.*

1. The permeation or penetration of one Body into or through another, by poroſities of the penetrated Body, either

either found or made by the penetrating Body; this is common almoſt to all Bodies, and is not the Penetrability in queſtion.

2. The ſeparation, diſtraction or diviſion of the parts of a penetrated Body by the force and energy of another Body; as the Arrow through the Air, or the Bullet through the ſides of a Ship; this is alſo uſual, and is not the penetration or penetrability in queſtion.

3. When one part or particle of Matter is taken into another portion of Matter by a kind of contraction, and ſwallowed up and drowned, as it were, in another portion of Matter, by a ſtricter union than it had before; whereby the ſame numerical portion of Matter hath a leſs extenſion and ſpace than it had before, and yet continues the ſame portion of Matter without diminution or encreaſe of ſubſtance, and this is that which is the Subject of the Queſtion in hand.

And this penetration of Matter or Bodies may be conſidered two ways.

1. When

1. When two diſtinct divided bodies or portions of Matter are ſaid thus to penetrate each other.

2. When the united parts of the ſame portion of Matter do penetrate and ſwallow each other, as is ſuppoſed to be done in *Condenſation*; and though the former be conſiderable, yet this latter is that kind of penetration touching which the Queſtion grows.

Secondly, Matter or Material Subſtance is the *Subſtratum* of Bodies; and although it is not poſſible for it to exiſt one moment without a determinate extent and determination into ſome Body compleated in *Eſſe Corporeo*, yet it is of it ſelf indifferent to any particular extenſion or bodily Concrement. This is that *Materia Prima*, the Subject of all Generation and Corruption, yet it ſelf ingenerable and incorruptible; that *Proteus* which in various ſucceſſions is capable of various Forms, Extenſions and Variety of Bodies; as we ſee in a piece of Wood thrown into the Fire,

that ſame material ſubſtance which but now was Wood, aſſumes ſeveral Natures and Extenſions, ſome more fixed than the Wood, as its Salts; ſome more lax, as Aſhes and Smoke, and accordingly undergoes Varieties of Extenſions different from what the very ſame portion of Matter had before: the very ſame individual ſuppoſed portion of Matter is capable of being determined into Air, Water, or ſome other Body; and if determined into Water, it may be the ſuppoſed portion of Matter would make up a Cubical Body of an inch ſquare; but if determined into Air, it would make a Cubical body of above 1000 times that extenſion, and yet the individual portion of Matter ſimply the ſame, and neither more nor leſs under thoſe different textures and extenſions; for Material Subſtance is naturally ſuſceptive ſucceſſively of various textures and conſiſtences, from whence do neceſſarily reſult ſucceſſively various extents or diminutions of that one individual

particle

particle of Matter under thoſe various conſiſtences.

Thirdly, Body is nothing elſe but Matter determined into a Body of this or that Nature, Figure, Texture, *Plexus*, Quality and Dimenſion; theſe are ſuperadditions to Matter, and being added to it, determine it into Body; and when this Body by the power of the Agent, aſſumes another diſtinct conſiſtence; then is that Body, either eſſentially changed into another kind of Body, or elſe accidentally altered in figure, dimenſion, texture, or otherwiſe, and yet the Matter continues entirely the ſame, as in ſome Bodies; the very ſame Cubique inch of Bees-Wax may be moulded into a Globe, a Cone, a Trigone, *&c.* and yet continues the ſame numerical and individual piece of Wax.

Fourthly, Quantity; and herein I ſhall take the Liberty to uſe this word according to my own ſenſe, abſtracted from others acceptation: I call therefore *Quantity* that Habitude

whereby a Material Subſtance under any determination is denominated more or leſs, and is a kind of proper inſeparable Accident (if we will call it ſo) of Material Subſtance, and intrinſick to it, and really differs from Extenſion or Dimenſion: For inſtance, a Cubique inch of Water is rarefied into 1000 Cubique inches of Air; or a Cubique Foot of Air is by heat rarified into five cubique Feet of Air; here is variety of Extenſion, and yet the ſame quantity of Matter in the cubique inch of Water, and in the cubique foot of Air, as is after *Rarefaction* in the 1000 cubique inches of Air, and 5 cubique feet of Air, *Quantity* being cloſely knit to Material Subſtance, but this or that particular extenſion variable, though the quantity (*i.e.*) the *Moles*, the muchneſs of Subſtance be the ſame.

And herein, among other things, it differs from Extenſion, that Extenſion is meaſured by artificial meaſures of Inches, Palms, Feet, Cubits; but Quantity, in my acceptation, is mea-

meaſured by weight, which gives the diſcrimination of Quantity or Muchneſs of Matter, where, it may be, the extent is equal; as a cubique foot of water is equal in dimenſion to a cubique foot of *Mercury*; but there is 14 times more weight, and conſequently more Matter and Material quantity in the latter than in the former.

Fifthly, Denſity and Rarity are various Qualities both of Bodies and Material Subſtance; and they are equally ſuſceptive of thoſe qualities, as they are of Colour, Figure, variety of Texture, or the like, namely, in ſucceſſive portions of Time or Duration: and hence it is infallibly true that the ſame Material Subſtance that is now actually rare, is potentially denſe; or that which now is actually denſe, is potentially rare, without any admiſſion of new Subſtance, or deperdition of any of the old. And as ſeveral portions of Material Subſtance are ſuſceptive of, or actually under ſeveral degrees of Rarity or Denſity, as Gold, Iron, Wax, Water,

Air; ſo the ſame portion of Material Subſtance may in ſucceſſive portions of times be ſuſceptive of ſeveral degrees of Rarity or Denſity; for, as I ſaid, they are but ſeveral qualities, or if you will, modes of Matter.

The Motion to Rarity or Denſity, is that which is uſually called *Rarefaction* or *Condenſation*; and though Matter or Body be ſuſceptive of it (ſome more eaſily, ſome more difficultly) yet it is moſt ordinarily the effect of an extrinſecal Agent, as Fire, Tenſion, Conſtipation, Compreſſion.

The Method whereby the alteration from Rarity to Denſity, or to a leſs degree of Denſity, and *e converſo*, is effected, is the alteration of the texture of the Body ſo rarefied or condenſed into a more dilate or contracted conſiſtence.

And this Alteration is ſometimes ſo great, that it alters the very nature or *Species* of the Body, as when Air is condenſed into Water, or Water into Air; ſometimes it only alters the

the texture, without altering the nature; as when Air is compreſſed into a narrower compaſs in Wind-guns, or dilated by heat in *Æolipiles*, it remains Air ſtill, though under differing texture from what it had before.

The effects of *Rarefaction* and *Condenſation* are neither increaſe nor diminution of the Subſtance thus condenſed or rarefied, nor of its quantity or muchneſs: If a cubique inch of Braſs were condenſed into Gold, indeed the *Moles* would be leſs in extent; but there would be the very ſame individual portion of material ſubſtance in both; and the very ſame weight that the cubique inch of Braſs had, would the portion of Gold have upon ſuch a condenſation: For weight and not extent is the beſt meaſure of equality or diſparity of material ſubſtance.

But indeed as to Extenſion, the meaſures would differ; the ſame *Moles* of Matter condenſed might not take up half the extent it did before,

and being rarefied, might take up ten times its extenſion or dimenſion.

Sixthly, Dimenſion or Extenſion; Though as Quantity imports much or little, it be inſeparable from the notion of material Subſtance, yet actual Extenſion in this or that determinate meaſure or degree, is but purely accidental to Material Subſtance; for it may have one extenſion one hour, and the next hour have another, as its texture is altered: For variety of extenſion is conſequential, and neceſſarily conſequential upon alteration of texture.

There are certain diſtinctions to be obſerved touching Extenſion, *viz.*

1. An actual, and an habitual, aptitudinary and potential extenſion, although *de facto* every portion of matter is under ſome actual extenſion, yet, as I ſaid, this or that actual extenſion is not intrinſecal or eſſential to Matter; for as it is capable of a variation of its texture, ſo it is capable of a change, variation and alteration

tion of its dimenſion. But that habitual, aptitudinary and potential extenſion whereby it muſt neceſſarily be at ſome time or moment under ſome determinate extenſion or other, is intrinſick to it, though it be ſucceſſively alterable as its texture is alterable.

Again, 2. We muſt diſtinguiſh between the extenſion in the ſuperficial and external dimenſion, and that which is the whole portion of Matter; the former may be without the true and real encreaſe of extent or dimenſion; for poſſibly by the diſtraction and ſeparation of the more interior parts of Matter, and the production thereby of poroſities, the external ſuperficial extent may be enlarged, and yet the whole extent continues the ſame, but only with a diverſified ubication of the more interior parts of Matter; but that extenſion which is intended by me in *Rarefaction*, is an entire extenſion of the whole Matter and all its parts, without which there is no true and adequate

equate extenſion; and that contraction or penetration of Material Subſtance to Condenſation, is the contraction of the whole triple dimenſion, length, breadth and thickneſs of the whole Body and every part, yet retaining the ſame quantity or muchneſs of Subſtance.

And as I have ſhewed that in ſeveral portions of Material Subſtance, it is not only conſiſtent with the Laws of Nature, but evidently true in fact that a portion of rarefied Matter (ſuppoſe it Air) may be, and is co-extended to all the ſpaces within the compaſs of that Matter, and fills them as entirely as a moſt denſe Body or portion of Matter fills all the ſpaces within its ſuperficial dimenſion (as ſuppoſe it Water, or even *Mercury* or Gold it ſelf) ſo the ſame portion of compacted Matter, ſuppoſe it Water or *Mercury*, being rarefied into a more dilated and expanded conſiſtence, as into Air or Fumes, may upon the very ſame account fill all the ſpaces within the extent of that dilated extenſion,

tenſion, without any *hiatus* or *interſtitia* of empty ſpaces, or the acqueſt of any additional Matter, becauſe the texture of that portion of Matter is only changed, and a greater extenſion or dimenſion is neceſſarily conſequential upon, or concomitant with the variation of the texture of that very ſame portion of Matter to a greater expanſion in *Rarefaction.*

Seventhly, The Contraction or Evolution and Expanſion of a Spirit or Spiritual Subſtance, which is commonly called *Penetration*, is incident to Spirits and Spiritual Subſtances, that are void of Matter; but this doth not at all impeach that natural penetration of Material Subſtance whereof I have ſpoken; for they differ *toto cælo* one from another.

1. In the principle of each Penetration: In Material Subſtance it always, or at leaſt, commonly, proceeds from an external efficient or force, as in Contraction or Penetration of Material Subſtances by compreſſion, or by conſtipations from without;

without; but the penetration or contraction, or dilatation of a Spiritual Subſtance, is from an internal principle, poſſibly the determination of the will of ſuch a Spirit to contraction or evolution.

2. In the Conſequent, or rather Concomitant of ſuch Penetration or Expanſion: In Material Subſtance, upon contraction or penetration, the Matter is neceſſarily thereupon more denſe; and in evolution or expanſion, more rare; for it cannot be one or other without the acqueſt of a new texture of its parts, *viz.* more lax in Rarefaction, more cloſe and compact in Condenſation; but in the contraction or evolution of a Spirit, there is no alteration in the texture, or Rarity or Denſity of a ſpiritual ſubſtance: For Rarity and Denſity are Qualities and Affections competible only to Bodies and Material Subſtances, not to Spirits or Subſtances purely immaterial; therefore I do diſmiſs the Penetrability of Spirits, as a thing wholly unapplicable

to

to the Matter in Queſtion, and no way applicable to the Argument in hand.

Eighthly, Now to apply the buſineſs of Penetrability or Impenetrability to what hath been formerly delivered.

Firſt, In caſe of ſeveral Bodies that are under ſeveral actual dimenſions, and not united one to another by continuation, this concerns not the preſent Queſtion, which is touching one common portion of Matter, whoſe parts are united one to another, and ſo in a ſtate of union: yet whether that a Body may not be of ſo high a rectified purity and tenuity, that it may penetrate the dimenſions of a groſſer Body without poroſities for its tranſition, either found or made in that penetrated Body, may be difficult to determine, becauſe we are unacquainted with the higheſt degrees of ſubtilty of Bodies, and conſequently of thoſe Energies that are conſequential thereupon: Only if Light be a Body, or if the Magnetical effuſion be corporeal effluxes as

ſome

ſome of the late Philoſophers aſſert, it ſeems to favour ſuch a penetrability of ſuch ſubtil Bodies; for Light will pervade every part of the *Diaphanum*, and Magnetical Effluxes will pervade the ſolideſt Bodies, even Gold it ſelf, as Experience ſhews us, without making poroſities for its tranſition. But I diſmiſs this as not to the Queſtion in hand; and poſſibly the Suppoſition that Light or Magnetical Effluxes are Bodies, is untrue.

Secondly, As to portions of Matter, Bodies and Extenſions thereof, where its parts are united in one common continuity, as in the caſe of proper *Rarefaction* and *Condenſation*, it ſeems that ſuch a penetration of actual dimenſions, or of Bodies determined in or under actual dimenſions, ſuch a penetration either of Bodies or actual dimenſions, or extenſions, is impoſſible and contradictory in it ſelf, ſo long as ſuch actual dimenſions continue unaltered by an alteration of the texture of ſuch Body, and conſequentially of ſuch actual dimenſions; for

a

a cubique Body of 12 inches cannot be more or leſs in extenſion than it is, ſo long as it is a cubique Body of 12 inches: This is that penetration of Bodies and Dimenſions that we do reject under that name.

Thirdly, But in as much as the very ſame portion of Material Subſtance is ſucceſſively capable of ſeveral textures, and conſequently of ſeveral dimenſions, there is nothing in Nature or Reaſon that prohibits a ſucceſſive penetration of Material Subſtances under ſuch a mutation of textures and actual dimenſions, ſo that one and the very ſame numerical portion of Matter that this moment is under a texture accommodate to the nature of the moſt ſubtil Air, being condenſed into a degree of Air leſs ſubtil, or condenſed into Water, its parts will be conſtipated and contracted into a cloſer poſture, and take up leſs ſpace according to the degree of its Condenſation; which contraction or conſtipation of its parts, may not improperly be called penetration of

of material Subſtance, but is not properly a penetration of Bodies, or extenſion actually determined, and remaining unaltered in its texture.

And this gives the difference between 1. Penetration of actual Dimenſions; and, 2. Penetration of Bodies. 3. Penetration of Material Subſtance. The two former are impoſſible without an alteration of the dimenſion or texture of the Body. The third is not only poſſible but neceſſary, and neceſſarily conſequential upon the alteration of the texture of the Body into a more rare or denſe conſiſtency.

And the evidence of the Truth hereof is, becauſe the ſame numerical portion of Subſtance material in a ſtate of Rarity, is as commenſurate to all the particles of Space within the compaſs of its external *Superficies*, and hath as perfect and undivided continuation of its parts one to another; as when it is condenſed into a conſiſtence that bears not the 100th part or 1000th part of the ſame ſuperficial

ficial dimenſion; for otherwiſe it were not poſſible to conceive, but that in the whole Body of Air and *Æther*, for one portion of Material Subſtance, there muſt be 1000 portions of empty ſpaces or nothings, which is againſt Nature.

And this Sentiment, though not warily enough examined and conſidered by ſome Philoſophical Heads, hath made them run on with one common cry againſt all penetration of Material Subſtances, under the name of penetration of Bodies and Extenſions, as a great abſurdity: But of latter times, ſome more conſiderate and inquiſitive perſons have ſearched more freely and impartially into this buſineſs; and though they do reject that impoſſible and contradictory penetration of Bodies and actual Extenſions or Dimenſion remaining unaltered in the ſenſe before given; yet do not only allow, as poſſible; but alſo aſſert, as natural and neceſſary penetration of the parts of the ſame individual portion of Material

Subſtance, conſiſting in a State of union, and under an alteration of textures, and conſequently a change of extenſions, as any man may ſee in the Learned Treatiſe of *Bodies*, of Sir *K. Digby*, pag. The large Diſpute of *Guarinus*, *Guarini Diſputatione* 4to *Expenſione*, 2. *De Rarefactione & Condenſatione*. And our Learned Countreyman, Dr. *Gliſſon*, in his Tractate *De Natura Subſtantiæ Energetica*, cap. 27, 28. Wherein, among other clear Explications of this Matter of Penetrability of Material Subſtances, he hath theſe Paſſages, namely, the prejudice that men have taken up againſt penetrability of Matter, is, *Quod ab ineunte ætate conſuevimus cogitare & dicere non dari penetrationem Corporum aut dimenſionum quodque ſimul pro conceſſo habuimus penetrationem Corporum & Subſtantiarum idem ſonare.* Again, *Impoſſibile eſt, ut manente eadem Extenſione, mutetur Denſitas, aut ut hac mutata, illa non mutetur; mutata dimenſione, ut in Condenſatione, Materia partes aliquas ſui quaſi abſorbet in ſeipſam.*

seipsam. And again, *Sola terminata extensio est quæ materiam durante eadem terminatione, & non diutius impenetrabilem præstat.*

Neither is this any Novel Doctrine, but the very Natural Sense of *Aristotle* in 4*to Physicorum*, cap. 9. before cited, and those expressions of the potentiality of the very same portion of Matter to become rare or dense, and thereby the Extension altered, without any diminution of its Matter in Condensation, or acquisition of new Matter, in Rarefaction; though it mention not Penetrability in express words, yet asserts the thing, as it is above declared.

Upon the whole Matter therefore it seems, 1. There is no necessity of a Supposition of a penetration of Dimensions on Condensation; neither is it indeed possible where the Dimensions continue the same, but would be a kind of contradiction. And,

2. Consequently where the Dimensions continue the same without alteration, it is impossible there should be

a penetration of Bodies or Material Subſtances, remaining under the ſame actual dimenſion unaltered.

3. But there is not only a poſſibility of the change of Extenſion, but the ſame will neceſſarily follow upon the change of the texture of the Body or Matter under ſuch Extenſion: And,

4. Conſequently the Extenſion there remaines not the ſame, but is changed. And,

5. Under ſuch a change of Dimenſion or Extenſion, or together with it, there may be, and will follow that which is called a penetration of Matter or Material Subſtance; for that which was the impediment thereof, namely, the actual Extenſion or Dimenſion is not only changeable, but now changed. And,

6. Therefore it ſeems no abſurdity in Nature or Reaſon, to ſuppoſe ſuch a penetration of Material Subſtances, in the caſe of *Condenſation*, and is the moſt reaſonable Solution of it.

And thus I have given an Accompt of what ſeems probable to me touching

ing this dark and intricate Enquiry touching *Rarefaction* and *Condenſation*; and therefore I have been the longer in it, becauſe I would be underſtood, and becauſe in the enſuing *Remarks* it is often urged againſt the Solution offered of the *Phænomena* of the *Torricellian Experiment*; and I ſhall remit the Anſwer of the *Remarks* of that kind to this Preliminary Diſcourſe; which, though poſſibly it may not ſatisfie every Reader, yet it will at leaſt render it evident, that the Objections made upon theſe obſcure and intricate Suppoſitions of impenetrability of Material Subſtance, are not ſo effectual, nor indeed proper to evince or prove, unleſs we had a clearer Diſcovery of the Nature and Affections of Bodies, than we have yet attained. And therefore Objections made from this Topique, loſe their uſe, in as much as the *Medium* is more obſcure than the very thing contended about. And now I ſhall proceed to the *Remarks* themſelves.

REMARKS upon the *Eſſay* touching GRAVITATION of *FLUIDS.*

REMARK I.

Upon the Second CHAPTER.

THis *Remark* fiercely, and in the firſt greeting, chargeth the Second Chapter of the *Eſſay* with contradiction, in that in ſome places thereof, it is ſaid, That *Gravity is a quality whereby heavy Bodies tend to the Center*; and yet in other places it is ſaid, That *Gravitation is but* Niſus *or* Conatus ad Motum; *and therefore that it is not improper to ſay, that Bodies that have a* Niſus *or* Conatus ad Motum verticalem, *do gravitate upward*; which the Remarker thinks to

to have been more properly expreſſed by *Levitation*; and to call it *Gravitation*, is repugnant and contradictory to what is ſaid of the quality of *Gravity*.

But to avoid a frivolous contention of Words, it might have been fairly and eaſily obſerved, that in truth all kind of *Gravitation* is but *Motion* or *Conatus ad Motum*.

But in that *Conatus* or *Niſus ad Motum*, we are neceſſarily to conſider two things.

1. The *Principium Motivum*.

2. The *Terminus Motus*, or *Conatus ad Motum*.

The *Principium Motivum* may be various, and tending to various terminations, it may be extrinſecal and accidental; as when I throw a Stone into a Bucket of Water, the motion of the Water is thereby cauſed upward, and raiſeth its *Superficies*, and the motion of the Water upward, is not altogether improperly called *Gravitation* upward, coming from an external force.

Again, The Principle of the Motion, or *Conatus ad Motum*, may be intrinſick, and from that intrinſick Principle, may have a motion or *Conatus ad Motum* downward, which I call the intrinſick quality of *Gravity*; this intrinſick quality governs and enclines the Motion and *Conatus ad Motum*, to a central termination, when it hath no collateral impediment. Any man with half an eye may ſee here is a *Conatus ad Motum* of the heavy Body to a central motion, which is its *Gravitation*, and yet the Principle that impreſſeth this kind of termination of its Motion, is that which I call, and call truly, the Quality of Gravity in the heavy Body.

In the very Inſtance of the Motion of Water in relation to the Rundle of Wood, ſpecifically lighter than Water, we may obſerve both theſe Gravitations or Motions the Water preſſeth downward from its intrinſecal Principle or Quality of Gravity, and thereby undermines and gets below the Rundle; and then by a relative, occa-

occaſional or accidental motion, in relation to the Rundle of Wood, it preſſeth upward, and drives up the Rundle of Wood with a force and kind of gravitation or motion upward to the *Superficies* of the Water: The ſame Water hath theſe various terminations, one downward, from its own intrinſick quality of Gravity, though the exerciſe thereof be ſuſpended till it find a lighter Body within its dimenſion to exert it; the other, upward, in relation to the Rundle of Wood, which by circumpulſion it drives upward.

And therefore the kind conſequences that I hold, there is nothing but mobility in Bodies, and that I uſe the phraſe of Gravity according to the vulgar acceptation, and as *Idolum fori*, or that the actual deſcent of Water or other heavy Body, is from a diſtinct Being, as is inferred in the firſt, ſecond and ſixth Sections of that Chapter, are but miſtaken Collections, and have no conceſſion from me or any thing I have therein aſſerted, nor are at all true, as I think. As

As to the 4th and 5th Illation in that *Remark*, where it is ſaid, *The Water hath no* Niſus ad motum *upward into the Tube immerſed, and ſtopped at the lower end, till opened*, that, in the Sequel of this Enquiry will appear not to be altogether true: But if it were never ſo true, yet it impugnes not what is above by me delivered; for the Water is driven up into the Tube by the weight of the body of the Water in the Bucket, upon the Cavity of the Tube filled only with Air, and ſo the riſing of the Water into the Tube, is by the preſſure of an accidental Poſition, and the fluidity of the aſcending Water, meeting with an Element in the Tube lighter than the Water.

We ſee in a pair of Scales a weight of two pound in one Scale, makes the weight of one pound in the other Scale, to aſcend, though both are heavy Bodies; and this by Mechanique and Statique Principles: So in the *Siphon*, A B, Water poured into the Leg A, raiſeth the water in the other Leg,

Leg, to an equal *Superficies*, upon neceſſary ſtatique grounds, without calling in any ſubſidiary Spirit of Nature to effect the aſcent; for the *Siphon* is a kind of natural *Libra:* And ſo when the Tube ſtopped with the Finger beneath, is immerſed into a Bucket of Water, and then opened, the circumjacent water being both fluid and heavy, is driven up into the vacant Tube, till it come to an equal *Superficies* with the reſt of the water in the Bucket, by a kind of due *Equipondium.* And all this is moſt regularly and neceſſarily effected according to the common Mechaniſm of Statique Principles, without any help from the ſuppoſed Spirit of Nature, to fetch out the Air out of the Tube, or to raiſe the Water into it.

There be many accidental cauſes of the motion of water vertically upward, which yet conſiſt with its intrinſecal principle or quality, which I call *Gravity*, or *Conatus* to a central motion; For inſtance,

1. It is moved upward by caſting into

into it a heavier Body, which takes up ſome of its room; as throwing a Stone into a Bucket of water.

2. It is moved upward by attraction; as in Pumps and Syringes.

3. It is moved upward, when within its own dimenſion it meets with a lighter body than it ſelf; as in the inſtance of the Tube of Air immerſed, and then unſtopped at the bottom; or where a Rundle of lighter Wood is immerſed in it, it is apparent the water raiſeth it, and caſteth it to the *Superficies* with a kind of Force; ſo that it will leap above the *Superficies* of the water, when it comes thither. But theſe accidental vertical Motions do not at all take away the intrinſick principle of its *Gravity*, but conſiſt with it; and therefore it is no contradiction to ſay that *Gravitation* is but *Conatus ad Motum*, be the motion lateral or vertical, or central; and yet at the ſame time to ſay, that *Gravity* is a quality in heavy bodies, that ſpecificates and determines their *Conatus ad Motum* to be central or perpendicular.

REMARK

REMARK II.

Deſcent of Bodies.

THis *Remark* would ſurely have have been ſpared, if the Author had been pleaſed to have read the next Page; where it is affirmed, that *Water powred through the Air, hath a direct central Direction and Gravitation*, Pag. 14. of the *Eſſay*.

REMARK III.

Touching the Gravitation of Parts of Solid Bodies one upon another.

THat every part of a Solid Body hath its common quality of heavineſs, and would in a ſtate of Sepa-

Separation, deſcend, and that every part contributes to the weight of the whole, is no where queſtioned; only when the Body is in continuity, and of an equal conſiſtence, that there is a ſuſpenſion of actual Gravitation of one part upon another, is that which is affirmed: But where they are of different Conſiſtencies, there many times happens actual and ſenſible Gravitation of one part of a Solid Body upon another. This is obſerved in the Third Chapter of the *Nugæ*, *pag.* 1. And had it been obſerved, the *Remark* I ſuppoſe would have been ſpared.

REMARK

REMARK IV, V, VI, VII.

Upon the Fourth CHAPTER.

FOr the rendring my Thoughts more intelligible, touching *Gravitation* of *FLUIDS*, and to make my Approaches to it the more eaſie and fair, I give in that Chapter Inſtances of ſolute ſolid Bodies, and how the preſſure of their parts are refracted, I begin with meer groſs Bodies, ſquare Stones of a foot ſquare; then deſcend to Wheat, Shot and Sand; and in theſe latter, I make my application to their own incumbency upon an Egg-ſhell, becauſe not ſo eaſily explicable by a perforation of their Baſe in reſpect of the exility of their Corpuſcles.

But yet I muſt tell the Reader, that allowing the proportion of their perforated Hole in the Baſe, to be but anſwerable to the exility of their Bodies,

Bodies, the coalition of more grains of Wheat, Shot or Granules of Sand at the ſame Orifice ſo proportioned, would ſtop their ſubſiding; as appears to any that thinks it not below him, to obſerve in Hour-glaſſes, where the paſſage, though big enough for one Granule of Sand, will not admit the paſſage of two or three crowded together; and Wheat will quarre in the Binn of a Mill if not ſhaken by the Clack.

But as to the thing deſigned by theſe Inſtances, it is only to ſhew how by various, eſpecially lateral preſſures, the preſſure of a Column of Stone, Wheat, Shot or Sand upon a ſubjected Body, is much broken. And certainly in ſolid Bodies, *ita ſe habent minora ad minora, ut majora ad majora.* If we had a good Magnifying-Glaſs, we ſhould find the piling of the Granules of Sand upon Sand, though not ſo regular as is done by Maſonry; yet holding a fair and well-near equal analogy to it; one Granule of Sand would appear to ſupport

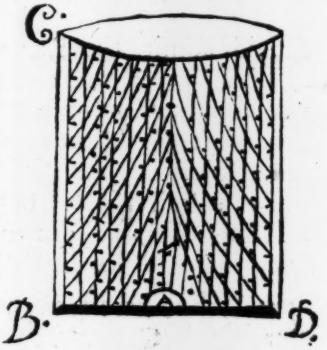
ſupport two or three, and thoſe again others; and the declivity of the motion of the Sands would be conſpicuous, and their bearing againſt the ſides of the Veſſel, and their declination from the middle of the Veſſel.

But the great Objection that is all along made, is, that the Corpuſcles of Water are not to be reſembled to thoſe of Sand, but are much more minute and glib, and therefore the Inſtances hold no proportion to that of water.

If I ſhould admit the Remarkers Aſſertion, that Water is no continued Body, but conſiſts of minute ſeparate Corpuſcles, yet it would not much advantage the Objection, for theſe Corpuſcles are not Indiviſibles, but Bodies conſiſting of trine dimenſion, and poſſibly there is not that diſproportion between ſuch an Atome of Water and a Granule of Sand, as between a Granule of Sand and a white Peaſe, much leſs a Cube of 12 inches ſquare. And certainly in Bodies, *ita ſe habent minora corpora ad minus ſpa-*

tium, *ut majora ad majus*: But I must not admit of this Supposition, that Water is no continued Body; for certainly Water conjunct, though it be a fluid Body, is as really a continued Body, as Steel or Gold.

But to render the Instances of Sand, *&c.* as reasonably explicative of this *Phænomenon* in Water, I shall subjoin and explicate this rude Diagram.



Suppose C D a Vessel of Water, with its various Lines of Declivity, and perpendicular direction, if you please,

pleaſe, A, the Egg-ſhell, F, my imaginary Cone or Cap, impending upon it, B A, and A D, a Circle of water in the Baſe of the Veſſel encircling the Egg-ſhell. I ſay it is impoſſible the Column of water incumbent on the ſhell, could preſs upon it, unleſs it could preſs upon and remove the circular Baſe of Water, encircling the ſhell, and unleſs that ſink or remove by the incumbent water, the Egg-ſhell can be preſſed no more in the inſtance of water, than that of Sand or Peaſe mentioned, *pag.* 7. of the *Additions* to the *Pamphlet*. But ſince the encircling water B A D, is of the ſame texture, weight and conſiſtence with the reſt of the water, it muſt remain unmoved as a Rock, and bear the preſſure both of the perpendicular and declining water, which muſt neceſſarily protect the ſhell from the entire preſſure of a Column of water commenſurate in Baſe to the Egg-ſhell, which cannot be without preſſing upon and diſplacing the circumjacent water, which is not poſſible; for now

the water incumbent upon the ſhell, and the circumjacent water, make, as it were, one common Baſis to the ſuperior water.

The analogy therefore between the inſtance of the ſand and water, and the accommodateneſs of the former to the explication of the latter, in this *Phænomenon* of the non-gravitation of Fluids upon included heavy bodies, conſiſts in theſe two Parallels.

1. Of the upper parts of the ſand or water, in relation to the lower parts, *viz. premendo* the lateral and inclining motion and preſſure of both, breaking and allaying their perpendicular or central preſſure.

2. Of the lower parts of the ſand and water in relation to the upper, *viz. ſuſtinendo* the Baſe of water or ſand, circumjacent to the Egg-ſhell, contributing to the ſuſtentation of the whole ſuperior maſs of ſand or water, and every particle incumbent upon that Baſe, ſuſtaining a numerous company of other Particles, and thoſe again others, ſo that the whole commenſu-

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rate Column of the ſuperior ſand or water (abating that ſmall proportion, which, for want of a better expreſſion, I call a Cap or Cone) incumbent upon the ſhell, cannot gravitate upon it. And thus I uſe my Maſonry of cubique Stones to explicate the manner of the gravitation of Sand, and the Arch of Sands, to explicate how the perpendicular preſſure of water upon a ſubjected body in a Column commenſurate thereunto, is remedied; only in Sand the Monads and their mutual ſuſtentation is more conſpicuous to the Eye, than in Water; but in Water the advantage is in ſome reſpect more effective of this alleviation by the continuity of its Matter.

Upon REMARK VIII, IX.

IT is thereby imagined, that the lateral preſſure being checked by the ſides of the Tube ſhould ſpend their direction perpendicularly downward, and ſo more endanger the ſhell, which, as it is evidently contrary to the Senſe and Experience of the fact, ſo it is contrary to Reaſon; for the tendency of the lateral motion is ſtill the ſame as at firſt, and the bare obſtacle of its expanſion cannot in a body of this nature, give it a motion of reſilition to a perpendicular gravitation; and if it could, it is impeded by the intervening Sand.

As to the 9th *Remark*, it is anſwered in the Obſervations upon the 4th and 5th *Remark*: But by the way, the jumbling of water hinders not its continuity, ſo long as the parts thereof are in conjunction one with another.

REMARK

REMARK X, XI.

IT is agreed between us, that Gravitation is *Niſus ad Motum*; but it never was, nor ever can be agreed by me or any perſon, that thinks before he writes or ſpeaks, that ſuch a Gravitation may not be excited and directed by a quality inherent in the Subject, which may terminate that motion, and incline and direct its motion to the Center. Gravity therefore is not of the ſame extent with mobility, but it is a mobility determined in its termination by the principle that puts it in motion, which, in the inſtance in hand, is the quality of Gravity, which is a determinate ſpecifical principle, determining the mobility of heavy bodies naturally to a central direction, though it may be ſometime accidentally impeded, and ordinarily impeded by the fluidity of a fluid body.

REMARK XII, XVI, XVIII.

THat the parts of Water, when in conjunction one with another, are only contiguous, I do admit by way of Argument; but I no where admit it by way of Conceſſion: for if I ſhould, I think I ſhould grant that which is by no means true. I only therefore in that place argue, that were the parts of water ſolute, and only contiguous, yet even there the actual gravitation of them would be ſuſpended as well as in Sand.

And becauſe the buſineſs of continuity and contiguity often occurs in the Remark, and great endeavours are therein uſed to prove the particles of Water and Air only contiguous, I ſhall here once for all, make ſome Obſervations touching Continuity and Contiguity, that I may avoid Repetition.

We learn both from the Ancient and

Modern

Modern Philosophy, that *Contigua sunt, quorum ultima sunt simul in situ, & non est possibile quod inter ea cadat aliquid quod habet situm. Continuum autem illud, cujus natura est quod inter partes ejus reperitur unus terminus communis*, or, *quorum ultima sunt unum in actu:* which is a little clearer explained by the Moderns, that *Continua sunt, quando ex pluribus quantis fiat unum totum nulla sensibili commissura inter partes remanente*; or, *implicatio & incorporatio partium unitarum*; so that they, as it were, run one into another without any sensible discrimination of their *Moles* or *Situs*.

Although in grosser Bodies there is more required than contiguity, to make them continuous, yet in Liquids, especially perfectly homogeneal, as Water and Water, Air and Air, *Mercury* and *Mercury*, there ariseth a continuity of parts meerly upon their contiguity or contingency; for thereupon they presently incorporate, implicate and mingle so one with another, that there remaines no possible distin-

diſtinction of the parts united; one drop of water touching another, one portion of Air touching another, one little globule of *Mercury* touching another, become perfectly continued bodies without more ado, though they were before divided by their diſtance, and interpoſition of another Body; this is apparent to our very Senſe, that theſe are undiſtinguiſhably united, incorporated and implicated one in another by their very contact, as cloſely, though not ſo firmly as Lead, Iron, or Gold, after Hammering or Fuſion.

In all Bodies that are in continuity, as there is a unity of Exiſtence, ſo (ordinarily, though not alwayes) follows a unity of motion. It doth not alwayes follow, becauſe there may intervene ſomething that may diſorder or break it.

But in things barely contiguous, as they are not in themſelves united ſo regularly, *ad motum unius non ſequitur motus alterius*, unleſs united by alligation, as in Chains of ſeveral Links;

or

by ſome other accidental intervention, as in the coheſion of diſtinct contiguous bodies, for the avoiding of Vacuity, as in poliſhed Marble, *&c.* And herein we may eaſily obſerve the continuity of Water.

Take a *Siphon*, and fill it with water, ſtopping both Legs with your finger, till the ſhorter Leg be immerſed into a Veſſel of water, the water will be entirely drawn out of the Veſſel by a *Funiculus* of continued water, aſcending and deſcending from the firſt immerſion, as is ſhewed in the *Additions* to the *Nugæ*.

But fill the *Siphon* with the fineſt Powder or Sand, that traction will never follow upon its immerſion into a Veſſel of the ſame or the like Sand or Powder; for in the former there is a traction by the continued Body of Water: But in the latter, the particles are ſolute, and only contiguous, and will not cohere, but gives us the Proverb of a Rope of Sand.

And what is here obſerved touching the continuity of Water, and the traction

traction wrought in the virtue of that continuity, is obſervable touching the Air, and the traction wrought by its filaments, as appears moſt evidently in the *Magdeburg Hemiſpheres*, in the 18th. Chapter of the *Difficiles Nugæ*, and in the raiſing and holding up of water in the heated Tube or Glaſs, deſcribed in the 16th. Chapter, which could never be effected, did the Air conſiſt only of contiguous and ſolute particles, unleſs we ſhould dream they were faſtened together by Hooks or Chains.

And upon what hath been ſaid, it is moſt apparent, that neither the ſoftneſs of the Air, nor its eaſie diviſibility or ſeparability by a Feather or a Cobweb, nor the attenuation of the particles of water into vapors, by the heat of the Sun, are ſo much as tolerable Reaſons againſt their continuity; for although the disjunction and ſeparation of the parts interrupt the continuity between the parts, when actually ſeparated, yet the ſeparability or eaſineſs of ſeparability of the

the parts of it, are not ſo much as a ſhadow of Argument againſt their continuity, till ſuch an actual ſeparation be made. No man that thinks twice, can imagine that Lead in fuſion, is leſs a continued Body, than when it was ſolid; or that Gold beaten into Leaf, is leſs continued than when in the Ingot, and yet the ſeparability of its parts much more facile than before. And therefore the Fancy of contiguity only of fluid Bodies, is the effect of that *Idolum Democraticum* or *Carteſianum*, which with his imaginary *Globuli*, and their *Ramenta*, the *Materia Subtilis*, hath diſordered mens Sentiments, as in many other things, ſo in this, touching *Continuity* and *Ratio Continui.*

REMARK

REMARK XIII.

I Am very well contented to be rectified touching the Nature of the *Principium Hylarchicum* of the Learned *Remarker*. I muſt confeſs, when I found ſo much of a Spiritual Nature attributed to it, and that great and ready accommodation of it to the ſolving of moſt of the admirable *Phænomena* in Nature, whether Mechanical or Vital, I thought it had been ſome intelligent Spirit or Intelligence; but now I underſtand that it is only plaſtick and vital, not intelligent, and doubtful whether ſentient or not: But of whatever nature it be ſuppoſed to be, it ſeems neceſſary to prove its very exiſtence by ſuch inſtances as are not meerly Mechanical; otherwiſe I fear more is aſſerted than proved.

REMARK

REMARK XIV, XIX, XX.

IN theſe *Remarks* lies moſt of the *Elixir* of the precedent *Remarks.* And beſides, they offer at ſomewhat of experimental proof of what they aſſert, beſides bare Notions; but how far theſe proofs are ſufficient or effectual, we ſhall ſee hereafter: And therefore I ſhall inſiſt ſomewhat larger upon them and the Obſervations that are to be made upon them.

Archimedes, in his Third Propoſition *De Inſidentibus Humido*, tells us, that if ſolid Bodies, having a Bulk or *Moles*, be equally heavy to the Water wherein they are placed, being let down into the Water, are ſo immerſed, that nothing of the *Superficies* of the Water is above them, yet they are not preſſed downward.

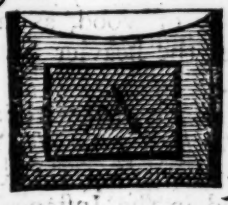
And in the Sixth Propoſition, he tells, that a Solid Body, lighter than the Water, being forced down into the

the Water, is driven up with ſuch a force, as the Water having an equal *Moles* to that immerſed Body, is heavier than that Body.

And this driving upward of the lighter Body, is by that circumpulſion of a heavier fluid Body upon another Body lighter than it ſelf, which will (if it can) take up the place that the lighter Body hath invaded within its Dimenſions, and the Limits of its Province.

And the truth is, the reaſon of the motion of a Ballance or *Libra Artificialis* in the Air, wherein a heavier weight in one Scale, lifts up a lighter weight in the other Scale, is in effect the ſame with this natural libration between the heavier Body of the Water, and the lighter Body of the Wood; only here it ſeems like a Ballance inverted, wherein the counterpoiſe of the *Moles* of Water being greater and more than the like *Moles* of a lighter ſolid Body, muſt needs overweigh it, and if it be poſſible, get below and under it, as in this Scheme.

Suppoſe



Suppoſe A, be a Cube of Wood of 6 inches ſquare, immerſed towards the bottom of the Cubical Veſſel of Water C D, and lighter than the like *Moles* of water, this Cube takes up the room of 234 ſquare inches, which (were not the Cube there) would be in a great meaſure taken up by the Water. The Cube of wood is environed with a quantity of water equal in *Moles* to this Cube of wood, but exceeding it conſiderably in weight, the weight of the water muſt neceſſarily preponderate the Cube of wood, and conſequently muſt thruſt it upward, that it may poſſeſs the place the Cube of wood hath invaded, and ſo in this *Libra Naturalis* the heavier *Moles* of

water muſt neceſſarily drive up the lighter *Moles* of wood, as in the artificial Scale, the heavier Scale raiſeth the lighter.

And hence it is that without the aid of an *Hylarchical Principle* the Water bears and carries up the Rundle of light wood in the Inſtance ſo often magnified by the *Remarker*. For unleſs the Rundle were ſo cloſely faſtned to the Baſe, either by ſome glutinous matter, or by its ſtrict jointing and adheſion to the ſides or Baſe of the Veſſel, as would be too ſtrong for the water, to diſplace it, it is hardly poſſible by any art whatſoever to make the Rundle ſo cloſe to the Baſe of the Veſſel, but the ſubtil particles of water will creep between the Rundle and the Baſe, and throw it up in ſpite of the imaginary Column of water, commenſurate to the Rundle that is ſuppoſed to keep it down: and herein, as I before obſerved, the water hath accidentally, and upon this occaſion a motion upward, which yet is but the Conſequent of its motion downward below the Rundle. And

And upon the ſame account it is, if you take a hollow Cane, ſuppoſe one inch diameter, 12 inches long, let the Baſe thereof be filled with a quantity of Lead for about an inch, then let there be powred in 6 inches of water, and then there will remain 5 inches of Air in the upper part of the Cane, although the Lead be heavier than ſo much water, and the water in the Cane equal in ſpecifical weight to ſo much water; yet as long as the whole weight of the Cane thus compounded, doth not equal the weight of a like *Moles* of water, this Cane immerſed into a Veſſel of water 12 inches deep, will not ſubſide or reſt at the bottom of the Veſſel, but will be driven up to that height in the water, that the parts of the Cane ſubſiding in the water, will countervail a *Moles* of water equal to the weight of the whole Cane, and there it will ſwim erect. Experience and the very Reaſon of the thing, makes the truth hereof apparent.

Stevin (that next to *Archimedes*, hath written beſt of *Hydroſtatiques*)

in his 5th Book, *Prop.* 2. ſuppoſeth nevertheleſs, that if this Rundle cover a hole in the bottom of the Veſſel, it will not riſe, but will be kept down by the impending Column of water commenſurate to the Baſe of the Rundle.

Albert Girard, the Commentator, denies this; unleſs the Rundle be of equal or greater weight than the like quantity of water.

But the truth lies between them both; for the Rundle lighter than the water, will be undermined in the Rims and Edges, and ſo the water will get out, do what the Artiſt can, if the Rundle be lighter than the like *Moles* of water.

But then when the water hath thus gotten a paſſage to paſs through the Orifice into the free Air (upon which it hath been ſhewn, the *Moles* of water commenſurate to the paſſage it hath now, preſſeth with its full ſwing) and if it meets with the Rundle in the way of its motion, ſo long as it ſtands in its way, it will gravitate upon it till

till the water hath wholly diſcharged it ſelf through the Orifice.

And therefore the reaſon is obvious why there is ſome impediment in the aſcent of the Rundle, when it is thus placed upon an Orifice, without calling in any other principle than the natural preſſure of the water upon that Orifice, now giving it an acceſs to an Element that it can preſs upon, *viz.* the Air below the Orifice.

Juſt as we ſee in our Kettles and Brewing Furnaces, when they have a ſmall Leak, the Servant throws in a handful of Bran, which though perchance it would not ſo readily ſink, much leſs ſink to the Leak, yet the motion of the water to the Leak, will carry thoſe light and ſmall particles thither, which being crouded in by the weight of that Column of water that is commenſurate to the Orifice of the Leak, ſtops it.

And the like is done upon a Leak in a Ship, where a light Fardel thrown out into the Sea, will be carried down to the Leak, and crowded into it by

the water, & ſometimes ſtop the Leak.

And therefore touching the gravitation of the Column of Water upon the Rundle of light wood, where there is a hole under it in the Baſe (which I add as an exception, *pag.* 57. and is no more than what *Stevin* tells us in the 5th Book of his *Practical Hydroſtatiques*) both He and I muſt be underſtood where any little water paſſeth under the Rundle to the Hole, and therefore to clear that Experiment, and the reaſon of it, I made exact trials concerning it, as followeth.

I took a Cylindrous Bucket of about eight inches diameter, and five inches deep, and made a round hole in the bottom, of two inches diameter, and a rundle of light wood of 4 inches diameter, to cover it, with a ſtick in the midſt,

to lift it up, or preſs it down, or to ſuſpend the Rundle by it to a Balance, according to the Figure in the Margin, and made it as ſmooth and even to the Baſe of the Bucket as I could, and preſſed it upon

the Orifice, and filled the Bucket with water, yet the water, do what I could, would preſs between the ſides of the Rundle and the Baſe of the Veſſel, and ſo diſcharge it ſelf in ſome ſmall proportion through the Orifice, and all that while it did ſo, the Rundle, though lighter than the like *Moles* of water, was kept down by the preſſure and iſſuing of that ſmall quantity of water, and ſo continued, till almoſt all the water had thus run out; the reaſon whereof is before given, *viz.* the motion of the water to the Orifice, kept down the Rundle. But then emptying all the water, and rubbing the Orifice and Rundle dry, I applied Neats-foot Oyl to the Rundle and Baſe, which by its glutinous conſiſtence kept the Rundle and Baſe cloſe together, and applied the Ballance to the hook of the Handle of the Rundle, and it was not ſevered from the Baſe by leſs than 7 ounces, though the Rundle weighed not above an ounce.

Then oyling the Baſe and Rundle as before, and uniting them, I filled the

Bucket with water, which by reaſon of the glutinous Oyl, did not paſs, nor ſever the Rundle from the Baſe.

Then fixing the Rundle as before, to a Scale, I tried what weight was ſufficient to ſever the Rundle from the Baſe, being under the ſuppoſed preſſure of that imaginary Colum of water of 5 inches deep, and I found that very near the ſame weight would ſever it from the Baſe under water, as did ſever it when it lay dry; and though in ſeveral trials there was ſome little diſparity, which might ariſe from the unequal ſtrictneſs of the juncture, either by the quantity of Oil, or poſition of the Rundle, wherein I could not poſſibly be exactly uniform, yet the Rundle was ſeparated under that *Moles* of water, ſometimes with ſeven ounces weight, ſometimes with eight; but at moſt, with ten ounces. And yet in the Column of water commenſurate to the Rundle, were 55 ſquare inches; which, according to the exacteſt computation of the weight of water, amounted to at leaſt 24 ounces weight:

weight: And this ſheweth that gravitation of the water upon the Rundle, is to be underſtood, when there is ſome paſſage to give the water motion. So that it ſeems to me, the Concluſion that the *Remarker* makes from this Inſtance, in favour of the *Hylarchical Principle*, or the ſuppoſed Gravitation of a Cylinder of water upon the Rundle where no water paſſeth, muſt be laid aſide, as no way aſſiſting his *Hypotheſis*, in impugning mine.

And therefore, whereas *Stevinus* in his *Practical Hydroſtatique*, *ubi ſupra*, grants, that the Body of a man, or other Body, lying flat upon the bottom of a great Veſſel of water, feels no conſiderable preſſure of the incumbent water, yet if there be a hole in the bottom of the Veſſel under that body, it ſhall find a conſiderable preſſure of the incumbent water; this is to be underſtood *cum grano Salis*, *viz.* if the Body do not ſo entirely and cloſely ſtop the Orifice in the bottom of the Veſſel; but that the water finds a paſſage between it and the Baſe, to diſcharge

it

it ſelf, the Body then indeed ſhall find a preſſure from the ſuperior water at leaſt, according to the weight of ſuch a Column of water as can thus diſcharge it ſelf between the Body and bottom through the Orifice. But if it ſtop the Orifice ſo entirely and cloſe, that no water can paſs that way, there will enſue no Gravitation upon the Body, by reaſon of that Hole or Orifice thus ſtopped; for it is as if it were not: the body becomes as it were part of the entire cloſe Baſe of the Veſſel.

And thus much may ſerve to explicate the *Phænomenon* of the orifice or hole in the Baſe of a veſſel under the Rundle.

But now as to the Inſtance given in the 20th *Remark*, whereunto the Learned *Remarker* appeals as an irrefragable Inſtance to take away at once the Mechanical Accounts of Continuity and Architecture, I doubt the Author gives us this Experiment without exact trial; for if he had tried it, I think he would never have urged it.

The Experiment, as I take it, is this; Take a Cylindraceous Bucket of

of 63 parts in the internal Diameter, and let another Cylindraceous Bucket be of 62 parts external diameter, with 4 ſloping holes at the bottom, and put the leſs into the greater, and fill them up with Water to the Brims, then take away your hand, and the narrower Bucket will emerge, leaving no more in the water than what is equal to the weight of ſuch a *Moles* of water as is equal to the whole Veſſel in weight.

I ſhall take this Inſtance in pieces, and then we ſhall ſee what is in it,

And for the better clearing of it, I ſhall make my way to it by Inſtances, though not altogether like it, yet giving a great light to it, and it may be, to other matters of this kind; and I ſhall firſt conſider the compariſon between Bodies ſpecifically heavier than the fluids, and then in Bodies ſpecifically lighter.

If there be a Bucket or a Cylindraceous Veſſel, ſuppoſe 9 inches deep, then take a Cylinder of 9 inches high, and narrower than the Bucket, but of a Material ſpecifically heavier than the

the like *Moles* of water, as ſuppoſe it Tin or Ebony; if the Veſſel be filled with a *Moles* of water of twice or thrice, or ten times the extrinſick weight of that Cylinder, yet the Cylinder will ſtill ſink to the bottom, by its advantage of its intrinſick or ſpecifical over-weight or heavineſs more than water.

Now I ſhall conſider the proportion where the ſolid Body is ſpecifically lighter than Water or other fluid Body in which it is immerſed.

I took a Cylinder of wood 4 inches deep, and 4 inches diameter, which weighed 18 ounces.

The like Bulk of Water equal in Bulk to that Cylinder of Wood, weighed 32 ounces.

So that the Water had a ſpecifical or intrinſick weight near double to the Wood.

And conſequently the Wood being immerſed in a Veſſel of Water, near one half thereof lay above the *Superficies* of the Water, as it muſt do according to the Rule of *Hydroſtatiques*.

I took 2 Cylindrous Veſſels, one of 6 inches diameter, the other of 9 inches diameter; I put the Cylinder of wood into the Veſſel of 6 inches diameter, and as much water as countervailed the Wood-Cylinder in extrinſick weight, but not in Bulk, and the wood-Cylinder would not ſwim; for though the intrinſick weight of the Water was near double to the weight of the Wood, yet the extrinſick weight of both was equal, *viz.* 18 ounces, and ſo there was an *Equipondium* between the Water and the Wood, and conſequently that Water would not raiſe the Wood from the Baſe of the Veſſel.

But putting in ſo much Water more into that Veſſel, as that the lateral or ambient Water would riſe ſo high as to cover a little more than one half of the Cylinder of Wood (namely, ſuch a quantity thereof as was equal to a *Moles* of Water, equiponderating the weight of the whole Cylinder of Wood) then the Cylinder of Wood would ſwim, though the

the Baſe of the Water between the Cylinder of Wood and the bottom of the Veſſel had not half an inch in depth.

And the reaſon is, becauſe the entire water both lateral, and at the bottom, is one continued body, and entirely preſſeth the Cylinder of wood upward, in as much as the lateral or ambient water hath gained an height upon the Cylinder, ſomewhat more than the immerſed parts of the Cylinder of wood proportionable to a *Moles* of water equal to the whole weight which that whole Cylinder of wood amounts unto; for the Cylinder of wood weighed but 18 ounces, but the whole weight of the water might be 20 ounces or more.

But again, put this Cylinder of wood into the Cylindrous Veſſel or Bucket of 9 inches diameter cloſe to the Baſe, and pour in four or five times the quantity of water into the Bucket more than what was in the former Cylindrous Veſſel of ſix inches diameter; as ſuppoſe it be five pounds of

of water, yet unleſs the *Superficies* of that water riſe not to more than the height of half the Cylinder of wood, *viz.* ſomething more than two inches high upon the ſides, the Cylinder of wood will reſt upon the Baſe, and will not ſwim: And the reaſon is, becauſe the water preſſeth according to its altitude, and not according to its amplitude, and therefore though the whole water in the 9 inches bucket be five times more in weight than the Cylinder of wood is, if it riſe not ſo high as to take ſomething more than half of the height of the Cylinder of wood, namely, ſuch a quantity thereof as is commenſurate to a quantity of water equal in weight to the whole weight of the Cylinder of wood, the Cylinder of wood would not ſwim, but will ſtand upon its Baſe at the bottom of the Veſſel. And this is the reaſon why a Ship or Veſſel that draws for the purpoſe 4 fathom of water, will ſwim in a narrow Cut or Channel that hath 5 or 6 fathom of water, though the Channel be leſs than

20 fathom over in breadth; and if the Channel were 20 Miles over, and of a leſs depth than the Ships draught of water, *viz.* 4 fathom, the Ship will be on ground, and will not ſwim, and yet the weight and quantity of whole water in the broader Channel, is many thouſand times more than that in the narrow Channel.

And the like Inſtance may be given in Floats of Timber in a deep and narrow Channel, and a broad and ſhallow Channel.

For the preſſure of water is more or leſs according to the height or depth of water, and not according to its amplitude or breadth, though the water with ampler *Superficies* be a thouſand times more in weight and bulk than the deeper water.

Now to the Buckets inſtanced in the *Remarks*;

If there be a Bucket of 20 inches diameter, and another of equal height but of 6 inches diameter, fill the leſſer Bucket with water, and place it in the middle of the greater Bucket, and then

then fill the circumjacent ſides of the greater Bucket with water, though the greater Bucket hold 5 times the water of the leſſer Bucket, yet (allowing, as I muſt, the wood of the leſſer Bucket to be but of the ſame weight with the like *Moles* of Water) the leſſer Bucket will ſtill remain contiguous to the bottom, and will not riſe one inch, and the reaſon is, becauſe the water without, and the water within the Bucket, though of a different *Moles*, yet have the ſame ſpecifical weight, and (as to this purpoſe) as if it were ſo much unveſſeled water (I ſay, as to this purpoſe, for as to the other purpoſes, there will be a difference, as I ſhall ſhew hereafter.)

But if the leſſer Bucket be totally empty, or only filled part with water, ſuppoſe half way, then the water in the greater Bucket, will drive up the leſſer; but not till only ſo much be immerſed as countervails its defect of weight, according to the *4th. 5th* and *6th. Propoſition* of *Archimedes, ubi ſupra.*

But now to come to the Experiment of the leſſer Bucket or Cylindraceous Veſſel perforated in the bottom, and then water poured into the greater or leſſer (for it comes all to one account) will the leſſer Bucket emerge, unleſs held down by the hand? By no means in the world; for the water will preſently paſs through the perforations from one Bucket to the other, till they come to one common ſuperficial height, and ſtill the leſſer Bucket will reſt upon the Baſe of the greater, becauſe they have an *equipondium*; ſuppoſing (as we muſt) that the wood of the leſſer Bucket is of equal ſpecifical weight to the like *Moles* of water. Indeed it is true, that if the holes be ſmall, ſo that there muſt be a *Mora* before the water can be conveyed from one Veſſel to another, then if the water be plentifully poured into the ſides of the greater Bucket, the leſſer will riſe till it have received ſo much water as equals the *Superficies* of both, and then the leſſer Bucket will ſubſide contiguous

to

to the Baſe; for the water in both Buckets being of an equal height, was in *æquipendio.*

So that as the Inſtance it ſelf conduceth little to the ends propounded, were it true; ſo I doubt it is miſtaken, and upon trial will not be found true.

I did expect to have met with an Objection which may ſeem *prima facie* to impugne what I have formerly delivered; yet upon a ſtrict examination it would not have any efficacy.

Take a Cube or Cylinder of wood of equal intrinſick weight with ſo much water, ſuppoſe it a Cube of ſix inches diameter, and put it into a Cylinder or cubique Veſſel of water of eight inches deep, and twelve inches diameter, this Cube or Cylinder would reſt two inches above the Baſe of the Veſſel, and would not gravitate either upon the two inches of water in the Baſe of the Veſſel, nor upon any Body that were but two inches thick, and lay between the Cube and the Baſe of the Veſſel of water, yet

here can be no lateral preſſure or *per declive* in the Cube, it ſelf being ſolid, and having only a central gravitation; ſo that it may ſeem the lateral preſſure which is the Subject of the Eighth Chapter of the *Eſſay*, applied to the Water, is no ingredient into its Non-gravitation.

I anſwer, that the Fact is true, but the illation thereupon is not conſequential.

In my Obſervation upon the *4th*, *5th*, and *7th*. *Remark*, I ſay the non-gravitation of *Fluids* is in relation to the preſſure of the upper parts upon the lower, which is *per declive premendo*: and in relation of the lower parts to the upper *ſuſtinendo*; now although in this Inſtance the former hath no part, yet the latter hath.

In this inſtance the Cube or Cylinder is ſuſtained and born up by the ſubjacent water, which is as the pedeſtal upon which it is bottomed; and therefore neither doth nor can preſs below the poſition it holds: But ſuppoſe the Body ſubjacent to it,

were

were 6 inches deep, then it would be under the preſſure of that Cylinder or Cube of wood, as much as the weight of 4 inches of the Cube amounts to in the water, and the body would be under a preſſure commenſurate at leaſt to ſo much weight as the Cube, or ſo much thereof as is thereby driven out of the *Superficies* of the water, exceeds in its extrinſick weight the like *Moles* of water, with ſo much of the Cube as lies in the water.

But on the other ſide, where there is nothing impending upon the ſubjacent body but the ſuperior imaginary Column of water, the ſubjected body is not compreſſed at 9, 6 or 3 inches immerſion below the *Superficies* of the water, partly by reaſon of the Mechaniſm (I do not ſay Maſonry of the water, though that expreſſion is frequently, but needleſly uſed by the *Remarker*) and partly by reaſon of the various termination of the motions of fluid Bodies.

It ſhall not be altogether impertinent to ſubjoin the enſuing Experiment.

I took a Cube of wood 4 inches ſquare, and very near of an equal ſpecifick weight of the like *Moles* of water; for it did not riſe half an inch above the water, and being let down to ſubſide freely in a Veſſel brim-full of water, it threw over a portion of water very near of the ſame weight with it ſelf, *viz.* 28 ounces and a half.

This Cube being laid into a Veſſel of 8 inches deep of water, therefore was raiſed at his Baſe about 4 inches above the water in the Baſe of the Veſſel, which water ſuſtained it. And now it had been unqueſtionable that if a body of leſs than 4 inches thick, had been ſubjected under the Cube, it would have ſuſtained no preſſure from the water nor from the Cube, which was entirely born up to that height by the ſubjacent water.

But if the body ſubjected to the Cube, had been 5, 6 or 7 inches thick, it would have been preſſed upon by various

various proportions from the impending Cube.

For fixing a ſtring and hook to the middle of the *Superficies* of the Cube, it required near 12 ounces in the oppoſite Scale, to raiſe the *Superficies* 2 inches above the water; near 20 ounces to raiſe it 3 inches above the water; and near 28 ounces and a half to raiſe the lower *Superficies* of the Cube equal in height to the upper *Superficies* of the water, which anſwered the full weight of the Cube of wood; and therefore according to theſe proportions, it would gravitate upon a ſubjacent body that gave it the like elevations.

But in water we ſee the preſſure different from the preſſure of ſuch a wooden Cube; for in whatſoever depth the ſubjected body is immerſed, whether deeper or ſhallower, it ſuſtains no ſenſible difference of the preſſure of the Column of water impending upon it, nor indeed any ſenſible preſſure at all, though at five or ten fathoms deep; which, as it gives us the

difference between the preſſure of a ſolid and fluid body, upon a body in water ſubjected to it, ſo it gives us the reaſon of it, *viz.* the preſſure of the ſolid body is impeded only by the ſubjected water, bearing it up, *viz. ſuſtinendo.* But there are two impediments that hinder the preſſure of the ſuperior water upon the lower water on the body under it, *viz.* the ſuſtentation of the ſuperior water by the inferior; and likewiſe the lateral and declivous motion of the water, refracting its perpendicular preſſure, while it is ſolute water.

And now becauſe that the various habitudes of heavier or lighter bodies immerſed in fluids heavier or lighter than themſelves, ſeems to be a pleaſant, and poſſibly a uſeful Speculation, and yet is difficult to be diſtinctly, and explicitly, and clearly declared: And poſſibly in what is before ſaid in this Obſervation, the ſame is not ſo diſtinctly delivered as might be wiſhed; I ſhall therefore deſire the Readers pardon, if I reſume

and

and repeat much of what is before ſaid, and digeſt the whole in ſomewhat a clearer method.

Firſt, I ſhall declare the difference between the terms of intrinſick and extrinſick weight, whether of fluids or ſolids, and what I mean by thoſe terms, and how one body is ſaid to exceed another in intrinſick or extrinſick weight, or both; That body which hath more of bodily *Moles* or Matter than another body of the ſame dimenſion, is intrinſecally heavier than that body which hath the ſame dimenſion, and yet hath leſs corporeal Matter or material Subſtance in it; and therefore is denſer and craſſer than the latter, and the indication of that denſity and craſſitude is by the overweight it hath over the other body; as a cubique inch of Gold is heavier, and therefore hath more of material ſubſtance than a cubique inch of Braſs or Iron; and a cubique inch of *Mercury* is heavier, and therefore hath more of material ſubſtance in it than a cubique inch of water.

And

And therefore a heavier body immerſed into a lighter fluid, as a cubique inch of Gold, Braſs, Iron, &c. into water, though it take up but the room and dimenſion of a like cubique inch of the water wherein it is immerſed, muſt needs ſink into the water, and drive up that cubique inch of water in its motion of deſcent; for it outweighs it: and as in an artificial ballance, the Scale that is charged with the greater weight, raiſeth up the other that hath the leſſer; ſo it is in this natural libration between the heavier body and the lighter fluid. And that I may here ſay it once for all, there is a moſt perfect analogy between the artificial Ballance and this natural Ballance, in relation to the motions of and in fluids; and he that means to have a true image of the latter, muſt attain it beſt by compariſon of it with the former.

A body that is ſpecifically or intrinſecally lighter than another, yet by acceſſion, or accumulation, or acquiſition of more parts of Matter than another

another body intrinſecally heavier, hath, may thereby extrinſecally, and in denomination, and alſo in its effect of preponderation, be heavier than that other; as two pounds of water is heavier extrinſecally, and in preponderation than a pound of Gold, though intrinſecally heavier: And therefore, if a Cube or Cylinder of wood be ſuppoſed intrinſecally lighter than water, yet if ſuch a Cylinder of wood, weighing 4 pounds, be immerſed into a like cylindrous Veſſel of water, which water hath not 4 pounds of weight, the cylinder of wood will ſink, and will not emerge, becauſe in extrinſick weight it exceeds the extrinſick weight of the water in the Veſſel into which it is immerſed. But if the water be of the weight of four pound and a half (and in a due poſition, as ſhall be ſhewed) the cylinder of wood will riſe and ſwim in the water, becauſe, now as well the extrinſick, as the intrinſick weight of the wooden cylinder is over-weighed by the water.

If a body that is intrinſecally heavier,

vier, be immerſed into a body intrinſecally lighter, as Gold into water, it will ſubſide, as hath been ſaid: But yet a body intrinſecally heavier than the fluid wherein it is immerſed, may accidentally be extrinſecally lighter than the body wherein it is immerſed, namely, when it acquires a Bulk or capacity ſo large, that a like *Moles* of water will be of a greater weight than ſuch an immerſed body ſpecifically and intrinſecally heavier, and then that body, though intrinſecally heavier, will ſwim upon the water, and be ſuſtained by it.

The moſt obvious Inſtances of this kind, are two, *viz.*

1. When that body intrinſecally heavier is mingled and concreted with other bodies intrinſecally lighter than the fluid wherein it is immerſed, and ſo the whole concrete immerſed body weighs leſs than the like *Moles* of water would weigh; as where a ſmall quantity of Gold or Lead is mingled with a greater quantity of wood lighter than water, and ſo both make

make up a concrete body lighter than ſo much water.

2. When the body intrinſecally heavier, is formed into a Cavity, as in Tin, Silver or Lead-Bottles, though the Material be ſpecifically heavier than water, yet if they have ſuch a dimenſion as that a quantity or *Moles* of water, of the ſame external dimenſion, will exceed ſuch Bottle (as it ſtands empty) in weight, this body intrinſecally heavier, yet extrinſecally is lighter than the water wherein it is immerſed, and therefore will be ſuſtained by it.

And upon this reaſon it is that Ships and other Veſſels are born up by the water, although they are often laden with great Ordnance, Bullets, and other things intrinſecally heavier than the like quantity of water; yet in as much as the whole Ship or Veſſel hath a great Cavity, and takes up room in the Sea, proportionable to that ſtructure, and a *Moles* of water commenſurate to the hull of the Ship, as it hath that concave

poſture,

poſture, is of much greater extrinſick weight than the Veſſel, therefore it is born up and ſuſtained by it. And thus a body intrinſecally heavier than a fluid wherein it is immerſed, may be extrinſecally lighter.

1. In reſpect of its concretion or compoſition.

2. In reſpect of its ſtructure and cavity, which gives a greater amplitude to it. That body is ſaid to be both extrinſecally and intrinſecally heavier, when it exceeds another body in both reſpects, as an Ingott of Gold that weighs two pounds, is both extrinſecally and intrinſecally heavier than an Ingot of Silver, weighing only one pound.

And thus far concerning weight extrinſick and intrinſick.

Secondly, The Second thing which I intend, is, to declare the various habitudes of heavier or lighter bodies, with relation to the fluids in which they are immerſed; whereby poſſibly much of the Learning and Experience *De inſidentibus humido*, may

may be explicated, namely,

1. Where a body ſpecifically or intrinſecally heavier, is immerſed in a fluid intrinſecally lighter than it ſelf, as Gold, Lead or Iron in water.

2. Where a body is immerſed into a fluid of equal weight with it ſelf, which though it may be difficult to attain, yet attainable it is, as ſhall be ſhewed.

3. When a body ſpecifically or intrinſecally lighter, is immerſed into a fluid, and intrinſecally heavier than it ſelf; as a Globe or Cube of Fir or Elm into water, which is much heavier intrinſecally than ſuch light Woods.

4. When a body intrinſecally lighter, yet extrinſecally heavier than that portion of fluid wherein it is immerſed, be equal in weight to it, as where a Globe or Cube of Fir or Elm, weighing ſix pounds, is immerſed into a Veſſel of water containing juſt ſix pounds weight of water, or any quantity leſs than it. Therefore,

1. If a denſe body being immerſed

in

in a fluid intrinſecally lighter than it, that denſe body will ſubſide to the bottom, though the fluid body in extrinſecal weight be more than forty times of greater extent than ſuch a denſe body; as if a Cube or Globe of Lead or *Mercury*, though but of an inch diameter, be caſt into the deep Ocean, for the Reaſons before given, where I treat of the difference between extrinſick and intrinſick diſparity of Gravity: Only it hath thoſe Exceptions before given, touching the mixture of ſuch heavier body with a lighter, and the configuration of ſuch denſe body into Cavity or hollowneſs, for the Reaſons there given, which I need not repeat.

2. If a denſe body be immerſed into a fluid of an equal intrinſick weight with ſuch denſe body, it is generally thought that ſuch denſe body will keep any poſition that it is put into, if placed near the top, or in the middle, or near the Baſſance of the Veſſel containing the fluid (though I have for the moſt part obſerved it to riſe

riſe towards the *Superficies* of the fluid, and hold its upper *Superficies* equal to it) as ſuppoſe a Cube of water ſix inches ſquare weigh 14 pound, a like cubique piece of wood of the ſame dimenſion and weight, will ſtand at all poſitions in a Veſſel of 7 or 8 Gallons of water; for ſuch a denſe Body is as ſo much water in this reſpect, they being of equal Bulk, and equal intrinſick weight. But it is a very difficult matter to find juſt ſuch an equality between Solids and Fluids, being of ſuch different textures. The beſt Expedient is by a hollow Vial-Glaſs, reduced to ſuch an *equipondium* by immiſſion of ſmall leaden Shot into it, till the Glaſs and Shot ariſe to the juſt *equipondium* of a Bulk of water equal to the whole *Superficies* of the Glaſs.

3. When a Body intrinſecally lighter than a Fluid is immerſed in ſuch fluid, part of that lighter Body will riſe above the *Superficies* of the water, or other Fluid into which it is immerſed, and will leave ſo much of it ſelf un-

der the *Superficies* of the water, as is equal to a Body or Bulk of water fully commenſurate to the whole weight of ſuch immerſed Body. For inſtance, Suppoſe a Globe of light wood of ſix inches diameter weigh 5 pound, and a globular portion of water of the like diameter weigh 10 pounds, this globe of wood immerſed in a large Veſſel of water, will riſe ſo that one half thereof will be above the *Superficies* of the water and the other half will be below the *Superficies* of the water; for the intrinſick weight of the water is double to the intrinſick weight of the wood; ſo that a portion of water equal to half the Globe of wood, weighs as much as the whole Globe of wood. And the like proportion will hold where the Globe of wood is lighter than the like portion of water by one third, or one fourth, or one ſixth part, *mutatis mutandis*.

4. If a groſs Body (ſuppoſe of wood) ſpecifically lighter than the like quantity of water, be immerſed into a quantity of water extrinſecally lighter than that

that immerſed Body, that Body, though ſpecifically and intrinſecally lighter, will not riſe from the bottom of the Veſſel, but will ſink down to the Baſe or bottom of the Veſſel, and remain contiguous to it, notwithſtanding the intrinſecal overweight of the water to the immerſed Body; as if in the former inſtance, a Globe of wood of 6 inches diameter, and 5 pound weight, be lighter by half intrinſecally than the like portion of water, if this Globe of wood be immerſed into a cylindrous Veſſel of 7 or 8 inches diameter containing 4 pound weight, nay 5 pound weight of water, the Globe of wood ſhall not ſwim nor riſe from the Baſe of the Veſſel, and the reaſon is apparent, becauſe though in intrinſick weight, the water is double to that wood, yet in extrinſick weight the Globe of wood in one inſtance exceeds, in the other inſtance equals the extrinſick weight of the water, and ſo the intrinſick weight of the water is over-matched by the extrinſick weight of the wood, and therefore cannot preponde-

rate it, nor conſequently drive it up; as in a pair of Scales, if there be two pound of Feathers in one Scale, and but a pound of Lead in the other, the pound of Lead, though intrinſecally heavier than the Feathers, will not raiſe the Scale of the Feathers, but will be raiſed up by them; and if in one Scale there be two pound of Feathers, and in the other two pound of Lead, neither Scale will be raiſed by the other, but ſtand in a ſtate of reſt, becauſe in *Æquilibrio*.

5. If a Cube or Globe of wood of ſix inches diameter, and weighing ſix pound, be but half ſo heavy as the like Globe or Cube of water (weighing for the purpoſe 13 pound) and be immerſed into a Veſſel of water ten or twenty foot ſquare, which is filled with water only to two inches deep; though this water be of an intrinſick double weight to the Cube or Globe of wood, and extrinſecally it may be above forty times more weighty than that Cube or Globe of wood; yet that Cube or Globe of wood will

ſubſide

ſubſide to the Baſe of the Veſſel, or reſt there in contiguity to it, without any ſwimming or bearing up above the Baſe of the Veſſel. And the reaſon is, becauſe the ſtrength of the preſſure of water is alwayes *ſecundum altitudinem vel profunditatem*, and not at all *ſecundum latitudinem vel amplitudinem*; and the water in the Veſſel riſing but two inches high, doth not equal the half weight of the Cube or Globe, which requires ſomewhat more than three inches of water to overmatch the extrinſecal weight of the Cube of wood, without which, it will not be moved by the preponderation of the water; but the wood will preponderate the energy of that expanded water, or at leaſt be in *æquilibrio* with it, and ſo not moved from the Baſe of the Veſſel.

6. But if in the Inſtance laſt given, a Globe of wood of ſix inches diameter, and ſix pounds weight, being but of half the weight of the like Globe of ſix inches diameter of water (weighing therefore 12 pound) be immerſed

into a cylindrous Veſſel of water of 7 or 8 inches diameter, and of ſuch a depth as may hold 7 or 8 pound of water, without being forced over by the immiſſion of the wooden Globe into it, and let there be but 7 or 8 pound of water powred into it, and then let the Globe of wood of half the intrinſick weight of the water be put into it; or let the wooden Cube be firſt put in, and then the 7 pound of water; here the water between the Baſe of the wooden Globe and the Baſe of the Veſſel, it may be, will not be an inch deep; but the water in the ſides of the cylindrous Veſſel may riſe four, five, or ſix inches higher. In this Inſtance, this wooden Globe will ſwim, and the reaſon is plain.

1. Becauſe the water in the Veſſel is not only intrinſecally, but alſo extrinſecally heavier than the Globe of wood, this weighing only *6* pounds, and the water in the Veſſel 7 or 8 pounds; but that over-weight of water alone would not be ſufficient to bear up the Globe of wood, as is ſhewed

ed in the next precedent Obſervation. Therefore,

2. The immediate reaſon thereof is, becauſe the ambient or lateral water between the Globe and the Veſſel, riſeth to above half the diameter of the wooden Globe, and preſſeth *ſecundum altitudinem*, upon the little portion of water next the Baſe of the Veſſel, as a weight of water of near 7 or 8 pound and ſo exceeds the whole weight of the Globe of wood.

But if by reaſon of the amplitude of the Veſſel, the lateral water encircling the Globe of wood, had riſen but an inch or two above the Baſe of the Globe of wood, that would never raiſe the Globe of wood from the Baſe of the Veſſel, but there it would ſtand contiguous to the Baſe of the Veſſel; or if the Globe of wood were put into ſuch a Veſſel of water, it would ſink to the bottom, for it preponderates the weight of the water in ſuch a poſition; theſe Figures will explain it.

In the leſſer Veſſel A B, where the 7 or 8 pound of water riſeth never ſo little above the diameter of the wooden Globe C, the wooden Globe of ſix inches diameter, and 6 pound weight, will ſwim: But in the greater Veſſel, or where by reaſon of its amplitude, the lateral water doth not ariſe above the diameter of the Globe, the Globe will not ſwim, but reſt contiguous to the bottom, though the water in that Veſſel were 20 or 40 pound weight.

REMARK

REMARK XXI.

THis *Remark* is ſufficiently anſwered before, where I ſay that heavineſs in bodies, is an intrinſick quality, that it is not mobility at large, but a ſpecial or ſpecifick mobility, whereby its Gravitation is naturally determined to be central. That mobility upward in heavy Bodies, is occaſional and accidental, and not purely natural, as a heavy body.

I muſt confeſs, I do not underſtand what the *Remark* means, when it ſays, that Water hath no tendency to motion downward, but when it is out of its place, what is meant by the place of Water? Is it a place determinate with relation to the poſition of the Vniverſe? If ſo, we find no place in Nature, but the Water will deſcend from it, unleſs it be in the very indiviſible Center, which though it be the termination of its motion, was ſurely never intended for its place, becauſe

cauſe never ample or capable to receive it; let the water be in the Ocean, or in the middle Region of the Air, or in the Bowels of the Earth, it will ſtill, as a heavier Body, deſcend, if it be not impeded: Or, is the place of it, that place where any portion of water is placed; ſuppoſe in a Veſſel upon my Table, or upon the top of my Houſe, or on the top of a Steeple; yet there this water will ſtill deſcend if it be not impeded? Or is it, that the Water having gotten into any place in its fluid conſiſtence, it is now become its natural place *per occupationem*, and all other Bodies invading that place, are intruders, and put it out of its place, and ſo give it a *Niſus* downward? But the Water it ſelf, when I remove a Veſſel of it out of the River, into a Boat, or upon the Shore, invades the place that the Air before had, and ſo cannot be the proper place of the Water.

So that upon the whole account, the Water unleſs otherwiſe impeded, muſt neceſſarily move downward in all

all poſitions, though ſometimes it hath an accidental or conſequential motion upwards; and by reaſon of its fluidity, a lateral motion: therefore I confeſs I am to ſeek what is meant, when it is ſaid that the *Niſus* of Water downward is occaſional, and *pro re nata* as well as upward, namely when it is out of its place.

REMARK XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII.

I Anſwer to the Demand, the Mobility of the Water downward, is natural, being thereunto, as a heavy Body, determined by the Principle thereof, *viz.* intrinſick Gravity, but the other Motions are either from its fluidity, or occaſional.

Though it be not pertinent to the Debate, yet it is plain that at the ſame time Water may have an occaſional motion

motion upward or laterally, and yet a natural motion downward. The Bucket of Water weighing 12 pound, will weigh as much when a Tube ſtopped below and immerſed, and then opened below, gives an occaſional motion to part of the Water upward into the Tube. And the ſame is apparent when it drives up a light Rundle of Wood from the Baſe to the *Superficies*.

The reſt of the *Remark* is principally levelled againſt Continuity of Water; the contrary whereof is here affirmed to be proved in the former *Remarks*. Indeed I find this often ſaid, but without any proof that I can find. And indeed it requires a very evident proof; for its Continuity is affirmed by all others that I know of, and is evident to ſenſe.

Concerning the motion and preſſure of Sand, I have ſaid enough; only where it is ſaid, that an Animal is not damnified under a high heap of Sand, may have ſome ſuch reaſon as the ſuſpenſion of Fluids; I freely agree herein; for, as I take it, the Animal is

is protected in both by the Mechaniſm of the incumbent parts, but not by ſuch *Hylarchical Principle* as the Author ſuppoſeth.

REMARK XXIX, XXX.

THat the natural gravitation downward, is not inconſiſtent with an occaſional gravitation lateral; yea, and in ſome caſes vertical, is moſt evident by what hath been ſaid upon the laſt *Remark*: And therefore thoſe other actual gravitations are not bare imaginations, but may be as real effects in Nature; as when a Bullet is ſhot out of a Gun in a horizontal Line, at the ſame time there is a *conatus ad motum Horizontalem & Centralem* (for otherwiſe the Bullet could never ſink from a ſtraight Line) the former is *conatus ad motum violentum*, and the latter *ad motum naturalem.*

But as to the diſtinction that I make between the fluid Water in the Bucket

ket and the Bucket, containing an entire Cylinder, conſtituted both of the Bucket and Water in it, and that the latter hath one ſimple motion downward, as a heavy Body, or as a Keg of Ice; but the fluid water in the Bucket, had as a fluid Body, thoſe various motions, which in this Chapter I aſſign unto it. I muſt confeſs, when I wrote it, I thought, and ſtill think it ſo plain, and intelligible, and evident, that I wonder it ſhould not be underſtood, or ſhould be thought a repugnancy in Nature.

The Water in the Bucket is perfectly a fluid Body, and hath its perpendicular motion downward; which is ſimply natural to it as a heavy Body, and its lateral motion belonging to it, as a fluid Body; by which it would drive out the ſides of the Bucket, near the top, eſpecially, were it not well fenced; and though by the ſtrong gards of the Bucket, it be kept in, that it cannot effect what it endeavours; yet it hath ſtill its *conatus ad motum lateralem*; but that *conatus* is ſtill kept in

in by the ſtrong ſides and bottom of the Bucket.

But the Bucket of Water is now one entire aggregate Body conſiſting of Wood formed into a Cylindraceous form, and Water contained within it, and ſo preſſeth ſimply centrally, as if the Water were congealed into Ice; or as if Water and Earth were mingled together into one ſolid Maſs, in which Inſtances the Bucket of Water preſſeth not as a fluid Body of Water, but as a common ſolid aggregate Body.

And now if you ask, But why doth not the Bucket of Water preſs laterally as well as the Water in the Bucket? The Anſwer offers it ſelf, even before the Queſtion asked; becauſe the ſides of the Bucket are ſolid, and not fluid, and can no more preſs laterally upon the circumjacent Air, than if they were empty of Water; the Water within the Bucket preſſeth upon the interior ſides and cavity of the Bucket, but is reſtrained from preſſing farther by the contignation of the Bucket,

Bucket, but the convexity of the ſides of the Bucket do not, cannot preſs upon the ambient Air; and ſo the whole weight is diſcharged from it in a central direction, as in truth it doth alwayes in a ſolid Body.

And the conſequence that would be drawn from hence, that then Water congealed ſhould be heavier than the ſame Water ſolute, is the vaineſt inference imaginable; for the Water as one common Body, had the ſame, and poſſibly a little more weight before its congealing, than after; and though its congealing hinder the various motions of it as a fluid Body, it doth not encreaſe nor conſiderably impair its weight upon the Scale as a heavy Body.

Methinks the Reaſoning of the *Remarker* in this Caſe, is juſt as if a ſhip were ſayling from North to South, a man ſhould ſay it were unconceptible that a Paſſenger ſhould walk upon the Deck from South to North; for then he ſhould be moved with two contrary motions, and of contrary

trary terminations at the ſame time, and yet is apparently true, that at the ſame time he is moved ad *motum Navis*, from North to South, and *ad motum proprium*, from South to North: ſo the ſame Veſſel of water, as it is one entire heavy bulk, hath ſimply its central termination; yet the ſeveral included fluid parts in their fluid conſiſtence, have and may have various terminations, as well lateral or inclining, as perpendicular or central.

But to put a period to this Debate, when I ſpeak of the various motions of fluids as fluids, I ſpeak of the motions of the parts of that common body which is fluid, and thoſe are horizontal, *per declive*, lateral and central. But when I ſpeak of its motion as one common body, then it is true the motion is central, which is its motion of natural gravitation upon the Scale; and therefore 12 pound of water without relation to the Veſſel wherein it is, will weigh ſtill 12 pound upon the Scale, and yet its parts have thoſe ſeveral motions before deſcribed, which

abate not the weight of the whole Maſs, but correct the particular preſſures of it, and the ſeveral parts thereof while *in fluore*.

And by way of illuſtration of what I ſay, take theſe few Inſtances; a Barrel of new Wine or Beer, ſuppoſe it weigh 100 pound, after a little time, it will gain a motion of fermentation, which by reaſon it proceeds from heat, is principally upward, towards the *Superficies*, yet notwithſtanding this motion, the Barrel of Beer or Wine, will as a heavy body, weigh as much as before the excitation of that motion, unleſs ſome of the Liquor be ſpent at a vent, or break the Barrel.

In Animals there is a great variety of the motions, not only of the Spirits, but of the Blood, the Chyle, the *Lympha*, and moſt conſiderably upward towards the Head and ſuperior parts of the Body, whereupon it was ſuppoſed by ſome Learned men, that the Body of a dead Animal that by ſuch death had loſt none of his blood ſhould weigh more than the ſame body living

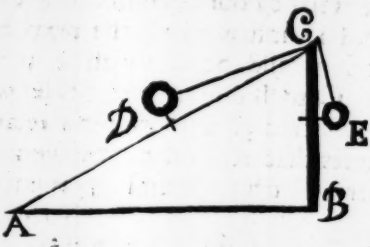
living; but upon ſtrict trials it hath been found that the weight continues the ſame upon the Scale; ſo that the various motions of the Blood, Humors, Chyle and *Lympha*, which are of a different, yea, and in many reſpects, of a contrary termination to that of natural gravity, doth not only conſiſt with the proper motion of gravity of the whole *Moles Corporea*, but doth not ſo much as abate it; yet theſe particular partial motions of the Blood, Humors, Chyle and *Latex*, may one correct the other.

And the ſame I ſay of Water; though there be particular motions of its parts, as a fluid body, and thoſe correct and refract one another; yet the motion of the entire *Moles Corporea*, as conſtituting one entire body, retains its entire weight upon the Scale, *viz.* 12 pound, and this without any repugnancy to, or diminution of the Laws of Nature, in relation to the deſcent of heavy bodies to the Center.

Take a Ballance, and charge one

Scale with 3 pound weight, the other with 2 pound weight, the preponderation of the Scale with 3 pound weight, will raiſe up the Scale with 2 pound weight, ſo that in a relative conſideration between the weights, the latter hath no ſenſible gravitation, and yet the hand that holds the Ballance, will ſuſtain and feel in both Scales together the weight of 5 pound; and it were an unreaſonable way of argumentation to urge, that becauſe the lighter weight hath loſt its actual gravitation in relation to the heavier weight, therefore the weight of both ſhould be but 3 pound, which is the preponderating weight of the heavier Scale.

If there be a triangular body made of Boards, Latin, or any other like Matter, whoſe Baſis A B, is parallel to the Horizon, and the Cathet B C, perpendicular to it, and 3 foot high, the ſubtenſe C A, 6 foot long, as in the Figure following, which is double the length of the perpendicular, it is demonſtrable that a weight E, of



of 2 pound weight, will counterpoiſe the weight D, of 4 pound weight, and that as the diſtance C A, is to the diſtance C B, ſo the *momentum* of the weight E, is to the *momentum* of the weight D. The moment of the weight therefore in the perpendicular deſcent C B, will be double to the moment of the ſame weight upon the declive ſubtenſe Line A C. That which I would obſerve in this Inſtance, is this.

1. That notwithſtanding this *æquipondium* in this Inſtance between the 2 pound and 4 pound, whereby the relative weight of each is abated, yet the entire Engin with its weights, will weigh 6 pound beſides the weight of the Engin.

2. That by the declivity of the motion of D, it loſeth half of that weight that it would have in a direct deſcent from C to B; and ſo this accidental interpoſition of a motion *per declive*, corrects that natural gravitation that is truly central and perpendicular.

3. But yet it doth not wholly remove or take it away, only the declive termination or direction takes off one half of the actual perpendicular or central gravitation. And this Inſtance explicates, and in a great meaſure proves what I have ſaid, and evinceth that theſe 29, 30 *Remarks* are not of that moment as the *Remarker* takes them to be.

So that upon the whole Matter, though a Tun of Water in a Veſſel, weigh 2000 pound weight, and that a man being laid upon his back in the bottom of that Veſſel, be ſubjected to a Pile or Column of Water, equal in Baſe to the half of that Tun of Water, yet the man ſhall not be preſſed with 1000 pound weight of Water, nor the

1000th

1000th part thereof; and yet the whole Veſſel of Water, or the whole water in the Veſſel, ſhall nevertheleſs weigh 2000 pound, upon the Reaſons given in the 7th and 8th Chapters of the *Eſſay*, without the help of an *Hylarchical Spirit*, whether intelligent, ſentient, or plaſtick only.

And thus I have done with the *Remarks* upon the Pamphlet, called, *An ESSAY touching the Gravitation of Fluids:* The Brief of what I have herein and there delivered, are as follow-eth.

I. That there ſeems to me a double Reaſon of the Non-gravitation of Fluids upon Bodies within them of a narrower Baſe at leaſt, than the Baſe of the whole *Moles* of the Water incumbent upon them; namely,

1. *Mechanical*, which is principally *ſuſtinendo*; the inferior parts of the Water ſuſtaining and bearing up the ſuperior, as analogical to the ſuſtentation of the ſuperior parts of Sands or other minute Bodies by the inferior.

2. *Natural, premendo*; which is the motion of the parts of Water it ſelf, as a fluid, though withal a heavy Body; which being *per declive*, and very near horizontal, corrects the central gravitation.

II. That although the *Moles* of Water, conſidered as one common Maſs or *Moles*, moves as a heavy Body, in a central termination, yet the Water and its parts conſidered in their fluid conſiſtency, have differing motions, as a fluid body, and with various terminations, *viz.* central, lateral, and *per declive*, which check and refract the preſſure of each other; ſo that the entire preſſure of the parts of water is not all one way, becauſe a fluid Body, though as one entire *Moles*, it preſs with one ſingle central termination as a heavy body, yet the parts thereof in their common conſiſtency, have various motions or *Conatus ad motum*.

III. That although the various *Conatus ad motum* of the parts of water *in fluore*, do correct the motions of water,

ter, in relation to their terminations, as a fluid body, whereby Divers (*Urinatores*) are not preſſed to death, yet theſe motions of its parts, as a fluid body, do not abate or alter the common motion of the whole *Moles*, when in one collection, in its central termination, as a heavy body.

IV. That beſides theſe motions incident to Water, as a heavy or a fluid body, there are or may be certain accidental motions *ab extrinſeco*, which may give water a vertical aſcending motion of preſſure, by an external force, as that motion which ariſeth by circumpulſion, where it meets with a lighter body below the *Superficies*, as in that of the Rundle of a lighter body, as a Rundle of Wood, the riſing up of Water into a Tube full of Air, the inſtance of the valve given in the enſuing *Remarks*; all which, though they partly happen from the fluidity of water, yet they are effected from an accidental interpoſition, and moſt ordinarily are conſequential upon a deſcent of the Water firſt, all which

which motions of parts of fluids, ariſing either *ab extrinſeco*, or from its fluidity, yet are conſiſtent with its intrinſecal quality of a heavy body, and the motion or *Conatus ad motum* of the entire *Moles* thereof in a central termination or motion towards the Center, which I uſually expreſs by a central motion or termination.

Touching

Touching the REMARKS *upon* Difficiles Nugæ.

REMARK I.

I Now come to the Second Courſe of *Remarks* upon *Difficiles Nugæ*, and begin with the firſt.

In this *Remark* the Learned Author hath fallen upon one of the ſubtilleſt Subjects in Philoſophy, and ſuch as would require more than a ſmall Treatiſe to give a tolerable accompt touching it, namely, *Rarefaction* and *Condenſation.*

I have more largely given an account of my thoughts touching it, in the beginning of this Book; whereby it will appear whether the Principles I take up, are unproved; or whether they or the *Remarkers* Principles be, or can be proved by any Experiment

ment or Reaſon in Nature, or whether his Principles or mine are ſuch as are repugnant to Reaſon, and abſurd, if we cloſely canvaſs them, and more conſiderately ſearch into them.

It was not in that place here remarked upon, neceſſary to prove them, but to ſuppoſe them; the proof was therefore there omitted: I having therefore now in the beginning ſupplied that defect in ſome meaſure.

REMARK

REMARK II.

THe Learned *Remarker* miſtakes the Scope of the Aſſertion; it is true that the conjunction of ſolid heavy bodies contribute to their weight, and conſequently to the motion of the whole ſolid body downward. But the actual gravitation of one part upon another, is ſuſpended by their continuity, the lower parts receiving, and ſuſtaining, and ſo *de facto* ſuſpending the actual gravitation of the upper parts upon the lower; ſo that although the ſuperior parts contribute to the total weight, yet they do not ſuperately and actually gravitate upon the lower parts.

REMARK

REMARK III.

I Muſt confeſs the ſubſtiturion of an *Hylarchical Principle* to perform all the *Phænomena* of motions in Natural Bodies, is a compendious and eaſie way for the anſwering of all difficulties: But he that but obſerves the Inſtance here endeavoured to be confuted, will find (as in many others, that I ſhall hereafter mention) they do not ſtand in need of ſuch a help; for it is meerly Mechanical, from the various Librations of the Water and Oyl, at various immerſions, by a kind of inverted natural Ballance between the Water and Oyl in theſe various poſitions, therefore I ſhall refer the truth of the Solution to the Readers trial, and what hath been before ſaid upon the former *Remarks*.

REMARK

REMARK IV.

IT is cautiouſly ſaid, that (in a manner) I acknowledge what is endeavoured to be proved in the firſt *Remark*: For in the *Atmoſphear* the Air is more compounded than above it, and yet all are connexed together by continuity, and ſo, in a manner, I do not acknowledge it alſo. Touching the continuity of the Air, it is ſaid by the Author to be ſufficiently diſproved, but it is only ſaid ſo: And I think the continuity of the Air is ſufficiently proved, and in it ſelf moſt evident, if no proof were offered of it.

REMARK

REMARK V.

THe excluſion of innate Gravity, becauſe the parts compreſſed will ſenſibly gravitate, but do not ſenſibly gravitate before compreſſion, ſeems to me as ſtrange a conſequence, as if a man ſhould ſay, a Feather hath no ſenſible gravitation, but a peck of Feathers put together, have a ſenſible gravitation; therefore there is no ſuch thing as intrinſick gravity in the Feather.

REMARK VI.

AND I have before noted, that Continuity conſiſts not in the facility or difficulty of ſeparation of parts, which yet till ſuch ſeparation, are in continuity, and when that ſeparation is paſt, may grow together into continuity again, by the firſt contact of the ſeparated parts, as the Air and Water do upon removing of what ſeparates their parts.

REMARK VII.

IN the 4th Chapter, *pag.* 64. of the *Nugæ*, I have given an account touching the various preſſure of ſolute and included water; namely, that in a *Siphon* there deſcribed, the Water in the open Air poured into the longer Leg, being 24 inches, depreſſed the

Mercury 2 inches and ¼, and drove it out of the ſhort Leg; but the ſolute water in an open Tube incumbent upon the ſhorter Leg, drove back only one inch, the longer Leg being empty: Now if the impelling down of 2 inches and ¼ of *Mercury* by the 24 inches of Water in the longer Leg, be no more than the preſſing down of one inch of *Mercury*, by the ſolute Water of 24 inches deep in the ſhorter Leg, the *Remarker* is in the right, and I was in the wrong; but if theſe be differing preſſures, and the preſſing down of one inch of the *Mercury* by the ſolute Water leaning upon the ſhort Leg, be leſs than the preſſing of two inches and ¼ by the 24 inches of Water included in the longer Leg, then I was not miſtaken; and a little Arithmetick will ſerve to diſcover it.

The *Remark* gives this Anſwer to this part of the Experiment, That more was impelled up by the ſolute Water, becauſe the ſhorter Leg was wider, and ſo required more *Mercury* in

in the other Leg to counterpoiſe it.

But to give the *Remark* ſatisfaction herein, I have made a moſt exact ſcrutiny into this part of the Experiment; and to the Objection I give theſe Anſwers.

1. The Cavity of the *Siphon* in the ſhorter Leg was $\frac{1}{8}$ parts of an inch, or $\frac{1}{4}$ of half an inch, the breadth of the Cavity of the longer Leg was not the 40*th* part of an inch leſs than the ſhorter, which is ſo ſmall a diſproportion that it could ſcarce be ſenſible, and this upon an exact admeaſurement: And again, when the *Mercury* in the ſhorter tube was depreſſed an inch by the ſolute Water incumbent upon it, there was not any viſible difference between the extent of the *Mercury* driven up in the longer, and depreſſed in the ſhorter Leg, both being indiſtinguiſhably the ſame, *viz.* an inch ſubſiding in the ſhorter, and an inch only riſing in the longer Leg, which evidenceth the imperceptibleneſs of the difference.

2. If it gave an advantage of raising of the *Mercury*, it must be to the shorter Leg, because it had a greater *Moles* of *Mercury* in it, and of Water upon it.

3. But the truth is, the pressure of Water or *Mercury* in an inverted *Siphon*, is equal, though the amplitude of the Legs differ; for Fluids in that Instance, press *secundum altitudinem* or *longitudinem*, not *secundum amplitudinem*. A *Siphon* inverted, having one Leg of 6 inches diameter, and the other but of an inch diameter, filled with Water or *Mercury*, will have their *Superficies* of equal heights, notwithstanding the disproportion of their amplitude.

This part of the Experiment therefore stands unshaken by the *Remark*, and therefore surely the Experiment it self, nor the Collection thereupon made by the *Remark*, gives little countenance to the magnified demonstration mentioned in the *Remark*, but concludes effectually against it.

Indeed as to the second Instance or Trial,

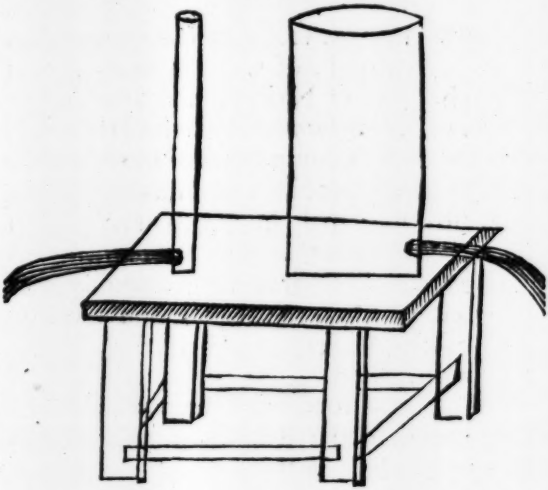
Trial, which I call the double Trial, *pag.* 66. it hath reaſonably given a juſt cauſe of exception, yet not without ſome Miſtake in the *Remark*; becauſe it was tried when two inches and more of the *Mercury* was firſt driven out of the *Siphon*, by the Water poured into the longer Leg, and therefore I lay no weight upon it; yet even there, there is a diſparity in the preſſure of the ſolute and encloſed water, there being a greater height of water preſſing upon the *Mercury* in the ſhorter Leg than in the longer: But becauſe this ſecond trial is leſs evident, I lay it aſide; yet howſoever this doth not impeach the former trial, nor the Concluſion which I lay upon it, *viz.* that the force of the ſame Column of water contracted in the longer Leg of the *Siphon*, and having no other Baſe but the *Mercury* it ſelf, is of greater force than the like Column of ſolute Water in the open Veſſel impending upon the ſhorter Leg, eſpecially ſince in the one caſe and the other, the open Air gives the moſt fair trial to the energy of both:

and therefore the diſparity of the preſſure of encloſed and ſolute water, which the *Remarker* is pleaſantly diſpoſed to call the Maſonry of the water, is not hereby impeached, nor the notable demonſtration in the *Enchiridion Metaphyſicum*, by the Rundle of wood any way relieved.

And for evidence of the truth of the preſſure of water *ſecundum altitudinem*, and not *ſecundum amplitudinem*, and alſo the diſparity of preſſure of ſolute water, and water under a conſtriction to a narrow Baſis, I have obſerved that if a Tube of half an inch diameter, and 4 foot high, with a *Lumen* of a quarter of an inch diameter in the ſide near the Baſe, be filled with water, the parabolical Line that the water will make out of that Veſſel in its firſt exſilition, will be as long, yea, and ſomewhat longer than the like parabolical Line made in the firſt exſilition, by the like *Lumen* out of a Veſſel of ſix inches diameter, and the ſame height, which muſt needs proceed from the

greater

greater preſſure by that Column of water that hath an equal height, but a Baſe of more equality to the *Lumen*, according to the ſubjoined Figure.



REMARK VIII, IX.

THe true reaſon of the riſing of the Rundle of wood is neither from the Spirit of Nature, nor from an *Hylarchical Principle*, but from the plain common known Rules of *Hydroſtaticks*, whereby neceſſarily a fluid Body drives up a ſolid Body lighter than it ſelf, to the *Superficies*, if it can by any means in the leaſt proportion, inſinuate it ſelf between the Rundle and the Baſe of the Veſſel, and this is done by circumpulſion.

But as touching *Stevinus* his Experiment of the Rundle covering a pertuſe or hole in the Baſis of the Veſſel, I muſt needs ſay, *Stevinus* delivers it in his Obſervations upon the 10*th. Propoſition* of his *Hydroſtatiques*, from whence I tranſcribe it, *pag.* 94. of the *Nugæ*.

I have ſaid enough touching this Buſineſs before upon *Remark* 19, 20.

upon

upon the *Eſſay*; I ſhall therefore ſhortly collect ſomewhat of what is there more fully delivered.

If the Rundle of Wood be ſpecifically lighter than a portion of water equal to its *Moles*, and the Rundle be preſſed down as contiguous as may be to the plain Baſis of the Veſſel, yet it will riſe; for by reaſon of the poroſities and chamfers of the wood, all the induſtry imaginable will not preſs it ſo cloſe, but there will be ſome *interſtitia* between the Rundle and the Baſis or bottom of the Veſſel into which the Water will creep, and ſo undermine and drive up the Rundle to the *Superficies* of the Water, by an aſcending preſſure of the Water, which aſcending preſſure is nevertheleſs wrought and effected firſt by a deſcent of the water round the ſides of the Rundle, and ſo by a kind of Ballance, overweighing the Rundle of wood, and thereupon neceſſarily weighing it up.

2. If the Rundle be cloſely fixed to the bottom by a viſcous, or glutinous,

nous, or thick Oylie matter, that the water cannot get under it, the Rundle will not riſe, upon this double account.

1. Becauſe that adhering Oyl by the mutual adheſion to the Rundle and Baſe, renders the Rundle conſequentially, and effectively, and extrinſecally heavier by its adheſion, than the like *Moles* of Water, whereby the Water cannot raiſe it.

But, 2. and principally, Becauſe the interpoſed viſcous Oyl doth obſtruct the migration or inſinuation of the Water between the Rundle and Baſis or bottom of the Veſſel, and ſo it cannot get under it to drive it up; but ſtands now as one common fixed Baſe of the Veſſel united to the true Baſe thereof,

3. If there be a hole in the bottom of the Veſſel, ſuppoſe of two inches diameter, and the Rundle of light wood be 4 inches diameter, and ſo overlap the Orifice, the Rundle will not riſe, becauſe the Water, notwithſtanding all the care imaginable, will creep

creep under the ſides of the Rundle, and diſcharge it ſelf gradually through the hole; for the water having never ſo little paſſage through the pertuſe or hole, though not commenſurate to the 40th. part of its amplitude, will contend and preſs that way, and ſo gravitate upon the Rundle that lies in its way, by its *Conatus ad motum* to that Orifice, where it finds never ſo little vent that it may diſcharge it ſelf; for the water preſſing upon and through the Orifice, doth neceſſarily preſs upon the interpoſed Rundle.

4. And if the Rundle of wood could be kept ſo cloſe to the bottom, either by its own exquiſite ſmoothneſs (which is hardly poſſible) or by any viſcous Oyl, or by any fixation to the bottom or Baſe of the Veſſel, now it ſtands as one common Baſe to the water, as the reſt of the bottom of the Veſſel doth, and is of no uſe to explicate the *Phænomenon*; for it is all one as if it were one continued ſolid Baſe to the Veſſel, unmoved and unmoveable by the water.

And

And this upon more than one trial; I find true; and when duly weighed, it makes nothing in favour of the *Remarkers Hypotheſis*, or to the diſadvantage of my Suppoſition in the *Eſſay*, though I confeſs it doth more diſtinctly and clearly explicate the *Phænomenon*.

REMARK X.

THe adequate Reaſon is truly given by me, if the Glaſs were exceſſively ſtrong, or if it were filled with water, it would not break, becauſe the internal water bears as ſtrongly againſt the external preſſure of the external water, as that can downward againſt it.

As we ſee in making new Cuts and Rivers; if there be a River with a ſmall or weak bank on its South ſide, and another Cut of Water be made on the South ſide of that ſlender Bank, the water in the River will not break the

the Bank; for the adjacent Cut filled with water, ſtrengthens the Bank by its renitence; but if the Cutt be empty of water, the Bank of the River will break, becauſe the conterminous Air is not of ſtrength enough to ballance it. The ſides of the Glaſs-Bottles of themſelves being too weak to protect them, and the included Air capable of compreſſion by the heavier Element of water, it wants ſtrength to protect it, and ſo breaks.

But as for the Air being out of its place when under water, I have obſerved enough before of the vanity of that Reaſon, and the enſuing *Remarks* will give me occaſion to re-inforce it.

REMARK

REMARK XI.

IF the *Remarker* had been pleaſed to take notice of what is ſo often mentioned in both the Tracts upon which he remarks, and is of infallible truth, that the preſſure of water in this Inſtance and divers others, is never *ſecundum amplitudinem*, but *ſecundum altitudinem*: Much of this *Remark* might have been ſpared, and the cenſure of abſurdity would have been reſerved to better purpoſe; for the water in the Pipe of one quarter of an inch diameter, muſt be counterpoiſed with a Cylinder of external water, of equal height and length to that in the Tube. And if the height be leſs, though the amplitude of the Water be more, it will not counterpoiſe it in this motion.

REMARK

REMARK XII, XIII.

I Come to the Inſtance which I call the *Valve*, he calls the *Obturaculum.*

I have given my reaſon of that *Phænomenon*, why the *Obturaculum* will not ſubſide in ſuch an immerſion into water; this is the Subject of *Cap. 6. Nugarum, pag.* 102, *&c.* and in the Obſervation upon the *Remark*; which is this in effect.

When the whole Tube with its *Valve* cloſed, is counterpoiſed with a portion of water of greater, or at leaſt, equal weight to the whole inſtrument, and of equal Bulk to ſo much thereof as is immerſed in the water, the whole Engin muſt neceſſarily ſwim; for it is in *æquilibrio* with, or preponderated by ſo much water, which it diſplaceth by its immerſion. And it is in effect no other, than if a Cylindrical Body, ſuppoſe a Cane, were

were of two inches diameter, and of two foot long, the bottom filled about an inch with Lead, and then 11 inches with Water, and the reſt with Air, and ſuppoſe the whole Cane were lighter than the like Bulk of Water, ſo that a *Moles* of water countervailing 12 inches of this Cylinder, would counterpoiſe it, it is abſolutely neceſſary that this Cylinder muſt ſwim perpendiculary and erect in the water at an immerſion of twelve inches; for the water bearing againſt its Baſis, muſt neceſſarily ſuſtain it at that height.

And perfectly the ſame reaſon is that which keeps up the *Obturaculum*, by preſſing againſt it at the bottom; which now is as it were one common piece of the whole Latin Cylinder or Valve; And this *æquilibrium* is the true Cauſe of its ſuſtentation.

But the *Remarker* hath given us another kind of Solution; which if I underſtand aright, is to this purpoſe, that in this Inſtance the Air is out of its

its place being in the Latin Cube below the *Superficies* of the Water, and that the Spirit of Nature, or the *Principium Hylarchicum*, to reſcue it from this inconvenience, draws up the Air, and drives down the contiguous water, and therewith draws and drives up the *Obturaculum*, which by the Abituriency (as it is called) of the Air, is ſuſtained: And as a ſtrong proof hereof, it is ſaid both in the *Remark*, and in the *Enchiridion Metaphyſicum*, that if the Tube be ſtopped near the Sucker or *Obturaculum*, it will by no means be ſuſtained; becauſe now the *Obturaculum* is not concerned in the abiturience of the Air thus ſeparated from it by the interpoſed obſtruction.

This I call an obſcure Solution; and had I then ſearched into it, as I have done ſince, I ſhould have ſtiled it a miſtaken Solution; for ſo it is.

1. I do not underſtand how the Air is out of its place, when it fills the Tube below the *Superficies* of the Water, any more than if the Veſſel were

placed upon a Steeple, the Air on either ſide reaching below the fund of the Veſſel, it may be 40 yards, were out of his place, becauſe the Bucket of Water ſtands above it.

2. Neither do I underſtand how the Spirit of Nature is concerned to fetch up the Air out of the Tube, or to bring the water into the Tube; but it is performed by a plain ſtatical neceſſity, and the relative preſſure of the Water upon the Baſis of the Tube, being lighter than the like *Moles* of Water.

3. Be it in his place, or out of his place; if the inſtance given by the *Remarker* of the falling off of the Valve or *Obturaculum*, when another *Obturaculum* is interpoſed, were as true as it is confidently affirmed, there might have ſome relief thereby been given to the Solution, which I called obſcure: But moſt plainly it is not true; and by frequent trials I have found that notwithſtanding that interpoſed ſtopping a little above the Sucker, or *Obturaculum*, the *Obturaculum* will continue

tinue ſuſpended as well as if there were no ſuch interpoſed ſtoppage. I took a Latin Tube of two foot five inches long, and one inch and a quarter diameter, with its *Valve* and *Obturaculum* cloſely fitted each to other, but ſo as with its own weight the *Obturaculum* would ſubſide in the open Air, the weight of the whole Engin weighed 12 ounces and a half and 9^{d} weight.

I ſtopped the Tube within leſs than an inch above the *Obturaculum* with Cork, ſo every way encompaſſed with a ſtrong Cement, that all poſſible intercourſe between the ſuperior Air and the lower brazen *Obturaculum* was entirely ſtopped.

The *Valve* or *Obturaculum* being put up, and the Tube immerſed into a full Veſſel of Water, ſubſided to 18 inches depth, and thereby drave over a portion of Water equal in weight to the weight of the Engin, and equal in Bulk or *Moles* to the 18 inches of the Engin immerſed in the Water; and all this while the *Obturaculum* ſtuck faſt; I therefore gently raiſed the En-

gin till it came within 5 or 6 inches of the *Superficies* of the Water, and yet it continued ſuſtained till it was raiſed to ſuch a height as the weight of the *Obturaculum* counterpoiſed a Column of Water commenſurate in weight unto it, aud ſo long the *Obturaculum* continued ſuſpended; but when the Tube was lifted higher, ſo that the *æquipondium* between the *Obturaculum* and the like *Moles* of Water was loſt, then the *Obturaculum* fell down, as in the inſtance of the *Valve*, that had no ſuch interpoſed obſtruction.

This was the event of this Experiment often made, and will doubtleſs fall out upon any other mans Trial, if it be carefully and ſoberly put in ure.

Only this muſt be remembred, if the *Obturaculum* be not very true and exact, but that the water comes in conſiderably between the *Obturaculum* and the *Valve*, the *Obturaculum* will fall off after a little while at leaſt, as well in this, as in the unſtopped Tube deſcribed

deſcribed in the Fifth Chapter of the *Nugæ*, partly by reaſon of the laxneſs of its adheſion, and partly by reaſon of the additional weight of water getting in above the lower *Obturaculum*.

And yet it muſt be remembred alſo, that though there be the greateſt care imaginable uſed, if the *Obturaculum* be ſo lax as to fall from the *Valve* in the open Air, though it be ſo cloſe as to ſtick together in the Water, the Water will creep between the Fiſſures of the *Obturaculum* and the *Valve*, with a force, if it have any room to receive it. And whether even that very preſſure of the water upwards through that Fiſſure, may for a while contribute to the bearing up of the *Valve* (as in the inſtance of the Rundles of Wood covering the Orifice in the Baſe, it contributes to the keeping down of the Rundle) may be conſiderable. But howſoever, if it receive too much water, it preſſeth the *Obturaculum* the more downward,

ward, and thereby in time weakens the adheſion thereof.

And now what part hath this *Spiritus Naturæ* to act in this caſe?

I ſhall therefore conclude this *Remark* upon which ſo great a ſtreſs is laid to prove the *Hylarchical Principle*, and the manner of its ſuſtaining the *Obturaculum*, by evocating the Air, and its ready obſequious abiturieney, to be not ſo much an obſcure, as a miſtaken Solution, and bottomed upon a miſtaken Experiment.

REMARK

REMARK XIV.

IN this *Remark*, the Author is pleaſant with his *Hylarchical Principle*, attributing to it a pretty kind of Intelligence, only where he ſayes, that it is the Pulp, not the Skin of the Finger that feels the monition of the *Hylarchical Principle*; it is certainly both; for the Pulp cannot be attracted, unleſs the intervening Skin be attracted.

The 15*th. Remark* will come to be conſidered hereafter.

REMARK XVI.

EXception is taken becauſe I ſay, regularly bodily effects are wrought by contact of ſome active body upon the Patient: The *Remarker* might, if he had pleaſed, have taken notice that I often ſay, In bodily motions ſome things act from an inward active principle inherent in them, as the deſcent of heavy Bodies. Other things there are that are moved by an external or foreign active principle, or at leaſt, ſome other body put into motion, as in a Clock, the deſcent of the weight of Lead is *ab intrinſeco principio*, and not by any contact, but the turning about of the Wheels of the Clock, is by the connexion of the Line to the weight, and its circumvolution about the wheel *per contactum*. To the former I never apply this Axiom, as he calls it, as he himſelf after in his 37th *Remark*,

Remark fairly confeſſeth. This active intrinſick principle I call the Law of Nature alligated to heavy bodies; and if he had called it an *Hylarchical Principle*, I ſhould not have contended with him about the word: But in theſe motions *ab extrinſeco*, I dare think at leaſt, he will not deny it to be regularly true.

REMARK XVII, XVIII, XIX, XX.

THere is no great matter in theſe, but only touching the poroſity of Glaſs; and the difficulty of the tranſition of the *Materia Subtilis* through it, by the renitence of the Air; upon which little more need to be ſaid than what occurs before.

Only where the *Remarker* ſubjoynes that upon the gentle gradual inclining of the Tube of *Mercury*, yet when it comes to an erect poſture the *Mercury* ſubſides to 29 inches, is an Argument

Argument that there are no ſuch *effluvia* from the *Mercury*, to ſupply the derelicted ſpace in the top of the Tube. This, though often repeated by him in the ſubſequent *Remarks*, ſeems to be no Objection; for whether the ſubſiding be more gradual, or more ſudden, the compreſſion of the *Mercurial* parts, and traction upon them, are equal when it attains its perpendicular preſſure; as to uſe my old compariſon, if a man ſtrain a Lute-ſtring from a lower to a higher Note, ſuppoſe from an *Eighth* to a *Third*, if he do it rapidly, he ſhall indeed endanger the Lute-ſtring; but whether it be wound up ſwifter or ſlower, the tenſion of the Lute-ſtring is the ſame at an equal height, in both motions of the Pin: Indeed while the inclination continues, the preſſure and gravitation of the *Mercury* upon it ſelf, is leſs, and conſequently the tenſion weaker; and therefore the portions of *Effluvia* ſent or drawn out in that poſture, are leſs; but when it comes to an erect perpendicular poſture, the preſſure and gravitation,

vitation, and traction and tenſion is equal, whether that poſture be attained ſuddenly or more leiſurely.

As to the length of the Tube, or its capacity in the top to receive more *Mercury*, as I have made the Objection; ſo the Anſwer that I give, that the more *Mercury* deſcends, the more *effluvia* are emitted, ſeems to me a ſufficient Anſwer, whether the Tube be leiſurely or ſuddenly brought to a vertical poſture.

REMARK

REMARK XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII.

THere is in theſe *Remarks* no difference between us; for it ſeems I write herein according to his Senſe; only in the Solution by me given by Tenſion, and Rarefaction, and Attraction thereby wrought, It agrees not to his Judgment, as contradicting the inſtance of the ſuſtaining of the *Embolus* of the Air-pump, upon which the *Enchiridion* layes great ſtreſs to prove an *Hylarchical Principle*; therefore moſt of the enſuing *Remarks* are levelled againſt that Solution.

REMARK

REMARK XXVIII, XXIX, XXX, XXXI.

TOuching the various poſition of the *Mercury* upon the top and bottom of a Hill, I need not ſay more than what is ſaid in my 14th Chapter of the *Nugæ*, and therefore I ſpare repetition. Touching the reaſon aſſigned by the *Remark* of the ſwelling of a Bladder, and the raiſing of Bubbles out of Water and Spirit of Wine in the Air-pump, by me attributed to Tenſion and Attraction, thereby wrought; but by the *Remarker* to a tumultuary agitation of the parts of Water, *&c.* As he is little ſatisfied with my explication, ſo I am as little ſatisfied with his; both indeed produce an agitation of the Water in the Glaſs; but that which I aſſign, is regular, orderly and ſutable to the effect produced; but the tumultuary agitation

agitation of the *Remarker*, is confuſed, irregular, and unproductive of ſuch regular motion; and beſides, is unevident, and contradicted by *Phænomena* of like nature; as we ſhall ſee plainly in the *Magdeburgh Hemiſpheres*.

The Ludicrous Inſtance, as I call it, of the Attraction of Tobacco through Water, is properly brought in by me in this place, to ſhew that in many Inſtances, Attraction may be made through Water, which was ſeaſonable in that place, and proper enough.

REMARK

REMARK XXXII, XXXIII.

IN theſe two *Remarks* the *Remarker* endeavours to ſhew,

1. The Groundleſsneſs of the Solution offered by me to the *Torricellian Phænomena.* And, 2. Its Repugnancy.

The former he ſaith he hath ſhewn in *Remark* 32. But all that is done to ſhew it, is to ſubſtitute certain inevident, and I think, miſtaken Suppoſitions: As,

1. The perviouſneſs of Glaſs to the ſubtiler aerial particles; this indeed he hath often ſaid, but no where proved; and if it were admitted, would not only perfectly deſtroy the apparent *Phænomena* in that Inſtrument, but would utterly confound his Anſwer to the reſiliency of the *Mercury* upon a ſudden lifting up and ſeparation of the Tube from the reſtagnant *Mercury:* For what need ſuch a violent reſilition

reſilition where the top of the Tube admits the ſubtiler aerial particles to pervade the Glaſs?

2. The gentle inclining of the Tube to prevent the tumultuary agitation of the *Mercury*. But what I have ſhewn in my Obſervation upon *Remark* 17, *&c.* I think ſufficiently diſcovers the impotence of this Objection.

3. The gravitation upward by a Circle of motion, is utterly unapt to ſalve the reſilition; for that circulation can be but a ſlow, gentle motion, and cannot poſſibly have ſo rapid a motion by the imaginary ſtraightneſs of the Channel; as we may ſuppoſe in the Streights in the Sea; upon which the Ocean preſſeth; but this neither can nor need receive a greater portion of ſubtil Air to relieve it than poſſibly 2 inches in height, and the 8th part of an inch in Diameter, where the amplitude of the Tube is no greater.

As to the Second, namely, the repugnancy which is aſſigned.

1. In

1. In that I deny a *Vacuum*, which he ſaith cannot be by another way prevented, but by the tranſition of the ſubtil particles of Air through the Glaſs; but ſuch a courſe of argumentation ſeems to be of kin to that which is called *Petitio Principii*, he knows I aſſign another cauſe, though he diſpute the truth of it. Then he proceeds to the leiſurely inclining of the Tube; which I confeſs is often repeated, but I think need not be more than once anſwered, which I think is done in my Obſervations upon *Remark* 17, *&c.*

Then he proceeds to the Argument touching *Rarefaction*, and the inconvenience of the penetration of dimenſions, and ſo endeavours to prove repugnancies in what is ſaid by a *Problem* that deſerves more diſcuſſion than the Argument in hand, as hath been ſhewed in the beginning of this Book, wherein I have nevertheleſs expreſſed my thoughts touching it.

I cannot tell what the *Remarker* imagines or conceives againſt the co-

heſion of groſſer Bodies by the tenſion of lighter bodies, but I can tell what is evident to my ſenſe, and ſo may any that will give his Senſes leave freely to determin, without ſtifling them by Notions, namely, that there is as plain a coheſion in the *Magdeburgh Hemiſpheres*; yea, and in the *Torricellian Engin*, as there is between things faſtned each to other by a ſtring: And therefore I cannot ſo over-readily change the conviction of my Senſes, for a Notion or Conception aſſerted and magnified, but not proved.

But to infer that becauſe Water, which is above 900 times craſſer than Air, is not compreſſible to a ſenſible ſmaller room by a great weight, therefore a portion of ſubtil Matter cannot be extracted out of it or *Mercury*, with ſo ſmall a weight as the Mercurial Cylinder, or that the *effluvia* of Water or *Mercury*, which are as ſubtil as Air, cannot be expanded by a leſs weight than Water compreſſed into a ſenſible narrower room, ſeem hard illations, and very inconſequential; for we

we ſee the heat of a mans hand will expand Air in Weather-Glaſſes to near a double extenſion.

REMARK XXXIV.

I Do prove the attraction of tenſed Bodies by the plain evidence of Senſe, and I aſſign the preſervation of the continuity of the Univerſe, as the end thereof, and the ſupream efficient cauſe thereof to be, the moſt wiſe and powerful Creator of all things, and the immediate effective cauſe, that inſtituted Law that he hath placed in things natural; the immediate inſtrumental cauſe in many motions that are not primitive in their Subjects, to be from the ſingular diſpoſition of the part of the Univerſe, & their admirable mechanical adaptation each to other. And as to the vicarious Spirit of Nature, as a diſtinct incorporeal ſubſiſtence, when the Author hath given us better proofs thereof than the ſuſpending of

Mercury in the *Torricellian Experiment*, the driving up a Rundle of light wood by the Water, and *potentia attractiva* of the *Embolus* of the *Air-Pump*, and ſuch like petty Inſtances, together with his bare Notion touching it: It may poſſibly obtain a better entertainment than yet I find it doth, at leaſt with me.

REMARK XXXV.

THis Inſtance in the Bladder and Cupping-Glaſſes, is paſſed over in this *Remark* very lightly, and it was neceſſary ſo to be dealt with, becauſe too troubleſome to be explicated otherwiſe than by Tenſion and Attraction, and it would require an admirable proceſs in the *Hylarchical Principle*; to effect this, and ſome proof beſides ſingle Notions and Conceptions of ſuch explication by ſuch a principle.

REMARK

REMARK XXXVI.

THe Inſtance here given, hath put the *Remarker* to a great deal of pains to find a ſolution for it and the conſequences of it (for the *Hypotheſis* of Attraction is confidently ſaid to be fully confuted, though it be only ſo ſaid, but not ſo done.) But yet the *Hylarchical Principle* is at length furniſhed with an *Hyloſtatical* Libration and *Hyloſtatical* power of union of the ſeveral parts of Water, Air and Glaſs: And at this rate I confeſs there will never want a ready ſolution to any difficulty; for it is but aſſerting that the Spirit of Nature is furniſhed with that effectual power, and the knot is untied or cut, though there be not a Syllable of proof offered for it; but it is only graffed on to the *Hypotheſis* of the Spirit of Nature by the wit of the Aſſertor, to accommodate the *Hypotheſis*.

REMARK XXXVII.

I Refer my ſelf to what is ſaid before in the firſt Chapter of this Book, and upon the ſame *Remark*, there need not be ſaid more.

The Laws of Nature were the Laws of God imprinted upon the nature of Phyſical Beings by his Almighty *Fiat*; and though as to particular Beings, he hath ſubſtituted particular active principles, uſually called Eſſential and Vital Forms; yet as to the Univerſe it ſelf, it ſeems to be too great an Empire to be put into the vicariat hands of that which is here called the Spirit of Nature. The great God that gave the Laws of Nature, is ſufficient without ſuch a Subſtitute, and is only ſufficient for the regiment of ſo great an Empire; and this may ſerve alſo to *Remark* 38. We are not diſputing whether ſuch a Spirit of Nature be poſſible to be, but whether *de facto* it be or not, or that it

it is neceſſary that it ſhould be, at leaſt as to thoſe motions which have ſo evident explication from other principles.

REMARK XXXIX.

HErein we differ not as to the rejecting of the great Elaſticity of the Air.

REMARK XL.

I Confeſs when I read the beginning of this *Remark*, I hoped to meet with ſuch a Solution to the Inſtance remarked upon, as would be cloſe and clear; becauſe this Inſtance bears ſo hard againſt moſt of what the *Remarker* hath before affirmed, but I was deceived herein.

In this Inſtance of the *Magdeburg*

Hemiſpheres, theſe things are moſt evident to any mans Senſe.

1. That the included Air is certainly expanded and rarefied by the heat, beyond its natural ſize.

2. That while they are ſo hot, and the Air ſo expanded and lax, they do not at all cohere.

3. That as they grow cold, they do moſt evidently cohere; ſo that they will not be divulſed without a conſiderable ſtrength.

4. That moſt neceſſarily as the included Air grows cold, and the heat which was the cauſe of its expanſion; decayes, ſo the Air muſt needs endeavour its reſtitution to its natural dimenſion, by contracting it ſelf inward to its natural ſize.

5. And yet if it have ſuch a degree of heat, as again gives a more lax ſtate to the included Air, the coheſion will ceaſe, and the Hemiſpheres fall aſunder.

6. And as the *Remarker* confeſſeth, and the moſt clear evidence of Senſe evinceth, thoſe *Phænomena* are not wrought,

wrought, nor indeed poſſible to be wrought, either by the weight, preſſure or elaſticity of the external Air, as the *Elateriſts* would have it.

The Conſequence of all which is, that certainly as far as Senſe can lead us, the Air is rarefied by the Heat; and as the Heat decayes, the Air endeavours its own contraction, and there neceſſarily follows, even to our Senſe, an attraction upon the ſides of the *Hemiſpheres*, whereby they cohere; and that coheſion will continue till relaxed by another acceſſion of Heat, or admiſſion of more Air.

But now what doth the *Remark* propound in this Inſtance? Marry, an *Hyloſtatical* Spirit, which, *pro re nata*, works theſe various *Phænomena*, which is only a conjecture, and hath no evidence to prove it beſides Notion or Imagination; but the method of the effecting it by this *Hyloſtatical* Spirit, is more admirable, though it is pleaſantly offered, that thereby all goes off glibly. And it is to this effect, as I take it.

The

The Hyloſtatical Spirit finding the ſubtilty of Matter impriſoned in an undue place between the Hemiſpheres, preſently makes up an occaſional Gravitation or Elaſtitity in the ambient Air to ſqueeze out the included ſubtil Matter, and give it liberty, and thereby preſſeth the Hemiſpheres together. And ſo in this glib *Hypotheſis* the *Remark* doth two things. *viz.*

1. It creates a weight or elaſticity in the ambient Air *pro re nata*, which as it is in effect contrary to all that he hath before delivered againſt the weight or elaſticity of the Air, ſo it hath this diſadvantage, as is propoſed by the *Remark*, that it is infinitely more incredible than the common Suppoſition of the *Elateriſts*, and indeed little leſs than miraculous.

And 2. It is a *Conatus* of this *Hyloſtatical* Spirit to no purpoſe at all, and meerly fruſtraneous, unleſs by ſuch an admirable condenſation of the ambient Air it could break the brazen Ribs; whereas indeed it makes the Priſon the ſtronger. I muſt confeſs, this Fetch goes

goes not down ſo eaſily with me, nor I believe with many more.

REMARK XLI.

I Come to the *Remarks* upon the *Phænomena* of the Glaſs-Pump, wherein I attribute the raiſing of the Water in the Glaſs to the traction made by the tenſed Air in the Shank of the Pump, and the dilatation of the Air in the top of the Glaſs, by the extraction of the Water. And the reaſon why after iterated evacuations of the Water by that ſuction or traction, no more will riſe, to be, becauſe the Air in the Bottle hath undergone as great a tenſion or dilatation as a Pump of that length can give it.

Theſe things I muſt obſerve touching this Pump.

1. The length of the Shank or Pump if ſelf above the Glaſs, was not much above fourteen inches, and the *Embolus* proportionable thereunto, if it had been

been longer, the attractive force muſt have been greater, and would probably have given a ſtronger traction, and conſequently a greater expanſion, tenſion or rarefaction to the Air in the upper part of the Glaſs.

2. That in this Inſtance here is no miſplacing of the Air or Water; upon which the Author builds much of the activity of his *Hylarchical Principle* in divers of his *Remarks*; for the Air in the Bottle, and in the Shank of the Pump, are both above the ſcituation of the Water in the Bottle. And here the Author, after ſome recourſe to the impoſſibility of penetration of dimenſions, which he ſo often inculcates, gives us his Solution, returns to the activity of the *Hyloſtatical Principle*, which becauſe the ſubtil Matter miſplaced, invigorates the external Air to do ſomething in this buſineſs, but tells us not expreſly what, or how, in this place: We ſhall hereafter, it may be, find what is meant.

Only he tells us two things. 1. That it is impoſsible ſo heavy a Body as Water,

ter, ſhould riſe ſo high into ſo extream a thin Body in the Glaſs, and that without freſh Air ſucceeding. 2. That the *Embolus* that at the firſt pumping, overcame the conſiſtence of the Air ſhould as reaſonably overcome it ſtill.

As to the firſt, It ſeems he is now pleaſed to admit an intrinſick Gravity in the Water, which renders it unwilling to aſcend; but beſides, according to the Authors Aſſertion in his *Remarks*, the more ſubtil parts of the Air will pervade the Glaſs, if that were true, there would be ſupplemental ſubtil Air at leaſt, to ſupply the evacuation of the Water to the laſt drop.

As to the Second, There is nothing more plain to onr very Senſe, than that any extendible or tenſible Body till it be broken, doth more eaſily yield to the firſt attempts of its extenſion, which yet with more difficulty, ſucceeds afterward as is evident in the Air-Pump and a Lute-ſtring, which is an Inſtance I frequently uſe, I confeſs; but it explains my meaning; ſo that this *Remark* concludes nothing againſt what

what I have delivered in relation to my Glaſs-Pump, nor to evidence the interpoſition therein of the ſuppoſed *Hylarchical Principle.*

REMARK XLIII, XLIV, XLV, XLVI.

BEfore I come to my Obſervations upon theſe *Remarks*, it may be convenient to give an explication of the dimenſions of the Glaſs-Pump that I made uſe of; referring my ſelf to the Figure thereof, deſcribed in the *Nugæ, Fig.* 21.

The whole length from the upper end of the *Embolus* to the bottom of the Glaſs-Globe, was near 21 Inches; whereof the *Embolus* reaching to D, near as low as H, where the Water was to be pumped out, was about 8 inches from H, to the upper Surface of the Glaſs, near 4 inches; from the upper Surface of the Glaſs to the bottom of it, about 9 inches, which was the diameter

diameter of the globular Glaſs; the continued Pipe of the Pump being leſs, running into the Glaſs about 7 inches, and ſo at E, opening and ending about 2 inches from the bottom of the globular Glaſs; conſequently from the lower end of the Sucker at D, to the middle of the globular Glaſs about 8 inches and a half or 9 inches; the cavity of the Pump it ſelf near two inches diameter or thereabouts; ſo that the Air between the bottom of the *Embolus* and the top of the Glaſs, might be a Cylinder of near 2 inches diameter, and about 4 inches long; by the tenſion whereof, the Water in half the Glaſs is by me ſuppoſed to be attracted and raiſed. The other and upper half of the Glaſs contains the other half of the Globe, and is filled with Air, which contained about 5 pints; which was more than twenty times the quantity of Air contained in the Pump, between the lower end of the *Embolus* and the top of the Water. I ſay, by iterated pumpings I drew out a quart of Water, which made the water

ter ſubſide in the lower half of the Bottle above an inch and an half; and conſequently the Air in the upper half of the Bottle expanded ſo, that now it contained about 7 pints of Air; after which, it was not capable of a greater expanſion by my ſmall Pump: The Engin it ſelf is more punctually deſcribed in the 19th Chapter of the *Nugæ*; but the dimenſions not ſo fully mentioned there as here.

This Inſtance I uſe as an evidence to prove the attraction of the Water by the tenſion of that little portion of Air in the cavity of the Pump and the ſequaciouſneſs of the Water to relieve that tenſion, and to preſerve the continuity of the *Mundana Materia* which in theſe *Remarks* is oppoſed by my learned Antagoniſt.

And the Inſtance is oppoſed upon this account, that the Air in the Glaſs is tended from 7 to 5; whereas the Air in the Pump is tended from 1 to 5 ſpaces at leaſt, which is ſaid, is an evidence that there is no ſuch tenſion; for if there were, the Air in the Glaſs would

would receive a greater tenſion than from 5 to 7, when the Air in the Pump is ſuppoſed to be tended from 1 to 5, which is ever proportionate to the tenſion of the Air in the Glaſs.

But ſurely this is an Objection of no force, for apparent Reaſons: Though the expanſion of 5 to 7, is not in proportion the ſame with the expanſion from 1 to 5, yet ſuch a proportion need not, nor indeed is poſſible in this caſe; for as the Body of the Air in the Glaſs, is above 20 times the quantity of the Body of the Air in the Pump, ſo ſuch an expanſion ſerves its turn, as may make good the ſpace that is left by the evacuated water, which being no more but one quart, the Air in the Glaſs can receive no greater amplitude of expanſion than one quart of ſpace more than it had before. The meaſure of the extenſion of the Air not being governed by the bare proportion which happens in another diſtinct portion of Air, and that of a leſs dimenſion: But by the room or ſpace that is left by its next contiguous Bo-

dy that muſt be ſupplied by its expanſion.

In the 45th *Remark*, that which was before wanting, ſeems now to be ſupplied, *viz.* The method which the *Hyloſtatical Spirit* uſeth in raiſing the Water in this and in other Pumps, *viz.* by a circular preſſure and gravitation of the Air and Water incumbent upon the *Superficies* of the Water that the bottom of the Pump is on, which jointly gravitates upwards, in regard of that ſubtil Element in the top of the Tube, that there may be no bare ſubtil Matter in the Pump, which gravitation and circulation is carried on by the *Hyloſtatical Principle*, that there may be no miſplacing of the Elements of the Univerſe, whereof the *Materia Subtilis* is one. This is the Solution in ſubſtance, and very near the words of the Learned Author.

This Solution, in my underſtanding, is not only wonderful inevident, but alſo very improper.

1. Here is granted an occaſional E-

laſticity

laſticity of the Air and of the Water alſo, though ſuppoſed to be effected by the Spirit of Nature or *Principium Hylarchicum*; which Elaſticity I had thought the Author would not have granted to Air, much leſs to Water.

2. But the Suppoſition of this Circulation encounters it ſelf: For either the *Materia Subtilis* (which is ſuppoſed ſubtil enough to pervade the Glaſs, though the craſſer parts of the Air cannot) is either a diſtinct Element of it ſelf, not incorporated with the Air, but of a diſtinct conſiſtence; or elſe is part of the aery concretion of the Air, the ſubtil part thereof, and mingled with the Air as one conſtituent part thereof, though in ſome caſes ſeverable from it; which way ſoever we take it, the difficulties of the Authors Suppoſition are unanſwerable. It is plain, the Air in the upper part of the Glaſs, upon the exſuction of a quart of Water, takes up a quart more of room or ſpace than it had before: If this be

cauſed by the perforation of the Glaſs by the *Materia Subtilis*, as a diſtinct Element, and ſo uniting it ſelf to the Air in the Glaſs, then this *Materia Subtilis* (which in reſpect of its purity, muſt needs have its proper place rather above the place of the Air, by the Laws of Nature, and not below it) is called down by the Spirit of Nature, from its proper poſition into the cavity of the Glaſs, and ſo the natural Order, Poſition and *Taxis* of the parts of the Univerſe diſordered and diſcompoſed.

Again, if the *Materia Subtilis* be but a conſtituent part of the Air, then is the ſame external Air robbed of part of its conſtitution, and impoveriſhed of what naturally belongs to it, to ſupply the ſpace in the Glaſs derelicted by the exhauſted Water, and that portion of Air in the Glaſs furniſhed with a greater portion of the *Materia Subtilis*, then belongs to it; and all this done by the Spirit of Nature, which is ſuppoſed to be an active plaſtick principle to conſerve the order

of

of the Univerſe, and not to diſorder it; which according to the Learned Authors ſuppoſition, muſt yet be the neceſſary conſequence of this imaginary tranſpoſition of the *Materia Subtilis* in this Circulation.

3. Again, in this Circulation and circular preſſure, we ſhall find the Chain broken, and the Circulation interrupted, or a worſe inconvenience; the Air in the Glaſs moves upon the Water, and that again preſſeth upward, and moves upon the ſubtilized Air in the Pump, and then it is thrown out in the open external Air, and ſo moves upon that: It remains therefore, for the compleating of the Circle, that now at laſt by the interpoſition of the *Hyleſtatical Principle*, the external Air muſt circulate by a preſſure upon the Air in the upper part of the Glaſs, and ſo the Dance is finiſhed.

But 1. We muſt note that even the Author himſelf agrees that the groſſer parts of the Air cannot pervade the Glaſs, but it muſt be the *Materia Subtilis*. I demand therefore, whether

this *Materia Subtilis* pervades the Glaſs, and is united to the Air in the top of the Glaſs or not?

If it do not, ſurely the Circle is broken, and with it, the circular preſſure or gravitation.

If it do pervade the Glaſs, and be united to the Air included in the Bottle, theſe inſuperable difficulties enſue.

1. The *Hyloſtatical Spirit*, whoſe Office it ſeems is to keep the Univerſe in its due Libration, and to preſerve the Air it ſelf in its juſt ſize and conſiſtency of groſs and ſubtil Matter, as is above obſerved; breaks that order that it is placed there to conſerve; for it takes too great a proportion of ſubtil Matter from the common external Air which is due to it, and crowds it into the Air in the top of the Glaſs, which hath already more, or at leaſt, as much as belongs to it.

2. It would follow that by ſuch a Current of ſubtil Matter through the Pores of the Glaſs, that the Water ſhould riſe into the Pump even to the laſt

laſt drop; for here is a perpetual ſpring and ſupply of ſubtil Matter, ſtrained every where through the Glaſs into the Air or aery ſpace that was in the head of the Glaſs, and no fear of any *Vacuum* to enſue by the paſſing away of the Water; ſo that it may (to uſe the Authors word) as glibly paſs to the laſt drop, as at the firſt, which is evidently contrary to experience.

This Circular Gravitation therefore is but a ſupplemental Invention, to help the Flaws that ariſe from the *Hypotheſis* of the Interpoſition of the *Hylarchical Principle*, as the true cauſe of this *Phænomenon*.

REMARK XLVII.

I Shall not need ſay any thing upon this *Remark*; for herein we are very much agreed; and he uſeth me and my Book with much Civility, and is pleaſed to contribute his own Learned Obſervations in favour of it.

THE

THE CONCLUSION.

I Shall not ſpend many words touching the Concluſion.

In ſome things therein mentioned, we very well agree; namely, in the excluſion of that prodigious Gravity and Elaſticity of the Air, whereunto the late Philoſophers attribute the Solution not only of the *Torricellian Experiment*, but many other *Phænomena*.

In ſome things we differ; he from me, in my Solution of many of the *Phænomena* mentioned in my Pamplets, by *Rarefaction*, *Condenſation* and *Attraction*.

I differ alſo from him, and the ſtate of that difference I ſet down ſhortly thus, both in the Negative, and in the Affirmative.

1. I do not deny, but do really aſſure my ſelf, there are created Spirits, ſome ſimply void of all corporeal or phyſical matter; others, that though poſſibly they

they may have a material or physical *Hypostasis* or *Substratum*; yet it is so subtil, that it may deserve the name of a spiritual being in common expression.

2. I do not conclude it impossible in Nature, but that there may be such a kind of common Spirit of Nature as the Author would have, and not much unlike to *Helmonts Archeus*, which he puts into a middle Office between the Soul and Body, or the *Coleoda* of *Avicen.*

3. But yet I do say I am not satisfied that there is sufficient evidence clearly to evince the same; & the rather, because I see no necessity for such a being, in as much as Almighty God and his intimate presence with all his Works, and the Laws that he hath alligated to the natures of things, abundantly supply all the general Offices for the common good and order of the Universe, deputed to this Spirit of Nature: And the particular active Forms or Principles of Life or Motion, placed by the God of Nature in the several Ranks

of

of Beings, ſupplies what is neceſſary for their particular motions, operations and inſtincts.

4. That the exiſtence of a Spirit of Nature is not at all proved by thoſe Motions and Effects in Nature, that are either purely mechanical, or that have any other immediate cauſe of greater, or but as great probability as ſuch an unſeen Spirit of Nature.

5. That conſequently the riſing of a Rundle in the Water, or the ſuſpenſion of a weight in the *Embolus* of an Air-Pump, the *Phænomena* in the *Torricellian Experiment*, or in the *Magdeburgh Hemiſpheres*, or in *Pumps* or *Siphons*, are non only invalid Arguments to prove ſuch an *Hylarchical Spirit*, but very improper and diſadvantageous to the Suppoſition it ſelf.

6. But if there be any ſuch *Hylarchical Spirit*, the proofs thereof ſhould be made from ſuch things as ſeem to have in themſelves the Principles of their own motions, or at leaſt, no other viſible or probable immediate external cauſe of ſuch their motions.

7. That

7. That if there be ſuch an *Hylarchical Principle* as is contended for, and that he doth interpoſe in many things that are not *Automata*, yet it is moſt reaſonable to ſuppoſe that the moſt exquiſite methods of Mechaniſm are the moſt probable *Media* whereby it performeth ſuch operations.

8. That therefore the Author of the *Remarks* ſhould not be too much averſe to the Mechaniſm of thoſe Motions in Nature, as purely inconſiſtent with his *Hylarchical Hypotheſis*; for hereby he renders it leſs credible, by denying things that are evident to Senſe, and tranſpoſing them beyond credibility, leſt they ſhould ſeem to prejudice his Suppoſition of an *Hylarchical Principle*. It is too much the faſhion of men engaged in Suppoſitions, to run into extreams, and that even in this Inſtance of *Mechaniſm* and *Mechanical Motions* in Natural Bodies; as I have ſhewed in the ſecond preliminary Chapter of this Book; ſome attributing too much to the *Mechaniſm* of things in Nature, and ſome too little.

And

And it ſeems to me that the Learned Author of theſe *Remarks*, out of the zeal he hath for the aſſerting of a moſt certain Truth, namely, the exiſtence of incorporeal Spirits, hath gone farther than was either fit or needful, in the attribution of theſe *Phænomena* in Nature, whereof we have been debating, to the immediate operation of an incorporeal vital Spirit; which he calls the *Spirit of Nature*; which yet are reaſonably ſalved by the *Mechaniſm* of Bodies, and the moſt wiſe Order, Inſtitution and Laws ſetled by the great Creator of all things, which Laws are called the Laws of Nature.

FINIS.

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